SCIENCE

FRIDAY, MARCH 6, 1914

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THE SOLAR CONSTANT OF RADIATION[1]

WE live in a world warmed by the sun. While it is not to be expected that everybody will devote himself to the measurement of solar radiation, yet it is not surprising that many have concerned themselves with measuring the quantity on which all lives depend. So far as I am aware, this subject was not pursued by the ancients to such a point as to obtain measurements worth much present consideration. This is a great pity, for thus we lack proof whether the sun's radiation has changed progressively. Beginning about a century ago investigations of solar radiation were pursued with great assiduity by various observers. The need was almost immediately perceived of reducing the observations to represent conditions outside the earth's atmosphere, as, for example, on the moon, so as to be independent of the haze and water vapor and even of the gaseous constituents of the air. It is required to know the measure of solar radiation in free space as an index of the condition of the sun, quite apart from its influence on terrestrial affairs, but secondly it is of great importance and interest to apply this knowledge to promote meteorological inquiries.

Sir John Herschel, who was a pioneer in solar radiation work, proposed to express solar radiation in terms of a unit which he called the actine, which is based on the melting of ice. But by general consent the gram calorie has been adopted as the unit of measurement, and we say that the

[1] Address delivered before the Philosophical Society of Washington, January 3, 1914, as retiring president.

"solar constant of radiation" is the number of calories per square centimeter per minute which would be produced by the complete absorption of the solar radiation in free space at the earth's mean solar distance.

Preparatory researches of great interest were made in the eighteenth century by Bouguer, Lambert, DeSaussure and Leslie. Determinations of the solar constant of radiation, however, may be said to have begun about eighty years ago with the investigations of Sir John Herschel, Principal Forbes and Pouillet. The problem comprises two parts: first, to measure the intensity of the solar radiation at the earth's surface; second, to estimate the loss it has suffered in passing through the atmosphere. It will be convenient to consider the atmospheric influence briefly before taking up the methods of measuring the solar radiation, and then to return to a more thorough discussion of the atmospheric transmission.

ATMOSPHERIC TRANSMISSION

The determination of the transmission of the atmosphere rests primarily upon the hypothesis of Bouguer, first put forward in the year 1729 and elaborated in Bouguer's posthumous work published in the year 1760. The late Dr. Langley has placed this matter in so very clear a light in his paper on the "Amount of the Atmospheric Absorption"[2] that I can not do better than to quote from his statement.

> If a beam of sunlight enters through a crevice in a dark room the light is partly interrupted by the particles of dust or mist in the air, the apartment is visibly illuminated by the light laterally reflected or diffused from them, and the direct beam, having lost something by this process, is not so bright after it has crossed the room, as before. In common language, the direct light, to an observer in the path of the beam, has been partly "absorbed," and the problem is, to determine in what degree. If a certain portion of the light (suppose one fifth) were thus scattered, the beam after it crossed the room would be but four-fifths as bright as when it entered it; and, if we were to trace the now diminished beam through a second apartment altogether like the other, it seems at first reasonable to suppose that the same proportion (*i. e.*, four fifths of the remainder) would be transmitted there also, and that the light would be the same kind of light as before, and only diminished in amount (in the proportion $4/5 \times 4/5$). The assumption originally made by Bouguer and followed by Herschel and Pouillet, was that it was in this manner that our solar heat was absorbed by our atmosphere, and that by assuming such a simple progression the original heat could be calculated.

[2] *American Journal of Science*, Third Series, Vol. 28, September, 1884.

If A_0 be the intensity of the original beam before entering the transparent medium whose transmission is to be investigated, then after the passage through the first stratum of unit thickness let us suppose a fraction of the original represented by p has passed through, so that what was A_0 becomes A_0p. Then since a second stratum identical with the first in constitution and thickness must, according to Bouguer's assumption, have an identical effect, the ray which was A_0 will emerge from the second stratum A_0p^2, and so on. The fraction p transmitted by the unit of thickness is the common ratio of a geometric progression, so that after passing through a thickness m of the medium, the intensity of the light which was formerly A_0 will become A_0p^m.

As the height to which the atmosphere extends in appreciable density is very small compared with the radius of the earth, the thickness of the layer traversed by a solar beam of a zenith distance not exceeding 70° is approximately proportional to the secant of the zenith distance of the sun at the time of observation. If we regard unit thickness as that corresponding to barometric pressure of 760

millimeters of mercury, then p in our formula corresponds to the vertical transmission coefficient of the atmosphere above sea level, and for any station where the barometric pressure is B the intensity of the ray from the sun as it reaches the earth's surface, which we call A, may be expressed by the formula

$$A = A_0 p^{(B/760)\sec z}.$$

Some writers have preferred to use the formula as a formula of "absorption" rather than of transmission. In that way the expression reduces to a somewhat different form, but its fundamental principles are the same. The investigations of Herschel, Forbes, Pouillet and others up to the time of Langley had reference to this exponential formula based upon the hypothesis of Bouguer, which was to the effect that successive equal layers of transparent material transmit equal fractions of the incident ray.

A convenient method of applying the atmospheric transmission formula is to take logarithms of both members of the equation so as to reduce the expression to the form of the equation of a straight line. Thus

$$\log A = \frac{B}{760} \sec z \log p + \log A_0.$$

By this equation the intersept of the best straight line on the axis of ordinates is the logarithm of the intensity of solar radiation outside the atmosphere, and the inclination of the line to the horizontal is the logarithm of the atmospheric transmission for vertical rays.

The reader must bear in mind that the simple expression thus far obtained is given only in illustration of the work of the earlier investigators, and it must be hedged about with certain conditions and limitations in order to apply it, as we shall see later, to the determination of the solar constant of radiation by the most approved methods.

INSTRUMENTS

Herschel's Actinometer.—This instrument consists of a thermometer with a large cylindric bulb, containing a deep blue fluid (the ammoniacal sulphate of copper) and enclosed in a wooden case blackened interiorly and covered with a piece of thick plate glass. The thermometer has a very large bulb, and it is adjusted in volume by means of a screw, so as to regulate the position of the column of liquid on the thermometer scale. Herschel introduced what is termed the dynamical method of observing the solar radiation, for he obtained not the total rise of temperature of the instrument when long exposed to the sun, but its initial rate of rise, corrected for the cooling or warming of the thermometer due to external conditions when the sun is shaded. The determination of the cooling correction is done by observing the rise or fall of the temperature for a certain time interval before exposing to the sun, and again determining the rise or fall after such exposure to the sun is completed. The mean rate of warming or cooling, due to the surroundings, is applied as a correction to the rate of warming due to the exposure to the solar radiation.

Pouillet's Pyrheliometer.—A flat metal box, blackened on the front, and filled with water, had a thermometer inserted at the rear, extending away from the direction of the sun. The instrument, like that of Herschel, was exposed to the influence of the surroundings while shaded for a certain interval of time the shade was then removed for a similar interval so as to allow the solar radiation to fall upon the blackened box, after which the instrument was again shaded. In practise it was found that the water within the box could not be well enough stirred in order to allow the average

temperature of the water to be well ascertained. The instrument was greatly improved by Tyndall, who substituted mercury for water, and, in order to contain the mercury, used iron in the making of the box.

Crova Alcohol Actinometer.—A large spherical bulb thermometer containing alcohol is enclosed in a nickel-plated metal chamber with a vestibule for the entrance of the rays. The stem of the thermometer runs back, directly away from the sun, and is enclosed in a nickel-plated tube with a side opening for reading the thermometer. A short mercury thread is introduced in the alcohol column at a suitable point for observing. The method of observing is the same as that adopted by Herschel and by Pouillet.

Violle Actinometer.—A large spherical double-walled enclosure filled with water is kept at a known constant temperature. A spherical blackened-bulb thermometer lies at the center of the enclosure, and the sunlight is introduced to it through a suitable vestibule in the double-walled chamber. Violle's method of reading was static, as opposed to the dynamic methods we have just considered. He observed the total rise of the thermometer and its fall after the cutting off of the sun rays, noting the position of the column at fixed intervals after exposure and after closure. The theory of the instrument as developed by Violle is simple and elegant. As a standard the instrument is open to the objection that the water equivalent of the bulb of the thermometer is very small, and difficult to measure, and that several corrections rather difficult of determination should be applied. It was used by Dr. Langley in his expedition to Mount Whitney in 1881.

Ångström Electrical Compensation Pyrheliometer.—This instrument has had the most extensive adoption in recent years of any form of instrument for measuring the solar radiation. It was invented about the year 1895. Two metal strips exactly similar to one another, and blackened upon the front, are exposed alternately to heating by the sun. Arrangement is provided for passing an electrical current through the strip which is not at the moment being heated by the sun. Thermo-elements fastened to the back of each strip indicate when the temperature of the exposed strip is equal to that of the strip which is electrically heated. Under these circumstances it is assumed that the energy of the electric current is equal to the energy received from the sun. About 160 copies of this electrical compensation pyrheliometer have been sent out from Upsala to different parts of the world.

Several other kinds of pyrheliometers have been used in recent years, among them two forms which have been devised by the writer. We shall have occasion to speak of these later.

EARLY OBSERVATIONS

Forbes observed with the Herschel actinometer in the year 1832 at Brientz and the Faulhorn. He showed that the transmissibility of sun rays continually increases as the length of path of the ray in air increases. Forbes rightly attributed this to the non-homogeneity of the solar radiation, and the inequality of transmission of the different component parts of it. Under such circumstances Bouguer's formula of course can not apply. Forbes concluded that equal barometric columns of air give equal transmission, whether taken from the high or low station. In this he was wrong. He formed an empirical curve to represent all his observations at both stations, employing air masses as abscissæ and actinometer readings as ordinates. Instead of extrapolating this curve directly to air

mass zero he preferred to find its tangents and thus derive the subsidiary curve of tangents from which he derived a formula for extrapolating his observations. In this way he obtained results corresponding to the value 2.85 calories per square centimeter per minute for the solar constant. Thus Forbes cut loose entirely from Bouguer's exponential formula of atmospheric transmission.

Pouillet observed in the years 1837 and 1838 at Paris. His work was published before that of Forbes, although made later. He found transmission coefficients by means of Bouguer's formula. He apparently did not investigate the defects of this formula as thoroughly as Forbes did. His result for the solar constant of radiation is 1.7633 calories per square centimeter per minute. This value, on account of the nonhomogeneity of the solar rays, is necessarily too low.

Quetelet observed with a Robinson actinometer similar in form to Herschel's, at Brussels from the year 1843 to 1853. These experiments might well repay a critical examination now, not for their value in determining the absolute measure of the solar constant of radiation, but in connection with the variation of the average intensity of the solar radiation from year to year as influenced by volcanic eruptions.

Desains employed a thermopile, and compared the transmissibility of the rays of the sun through a water cell at different stations. He found the transmissibility of solar rays through the water cell always increased by a long preliminary course through moist air. This result is essentially the same as that of Forbes, although obtained in a different manner.

Violle observed at many different stations, including Mont Blanc. His instrument apparently read much too high, as noticed by Langley in the report of the Mount Whitney expedition. He used a somewhat complicated empirical formula of extrapolation, as he was fully cognizant of the defect of Bouguer's formula, as indicated by Forbes. He obtained the following values:

	Outside Atmosphere	Mt. Blanc	Grand-Mulet	Bossons	Paris
Altitude	—	4.810	3,050	1,200	60
Barometer	0	430	533	661	758
Calories	2.54	239	2.26	2 02	1.74

These values should be reduced about one fourth to make them comparable with observations made in recent years at high elevations by many observers. In such a case the value outside the atmosphere would become about 1.9 calories per sq. cm. per minute.

Crova made many observations at Mont-Pellier with his alcohol actinometer standardized against the Tyndall pyrheliometer. He made some attempts to extrapolate his observations to the limit of the atmosphere, but these, like other solar constant values obtained by pyrheliometry alone, are not definitive. Great value, however, attaches to the long series of direct observations continued from the year 1883 to 1900 at Mont-Pellier. These show plainly the influence of the volcano Krakatau and others.

K. Ångström observed with the electrical compensation pyrheliometer at several stations at different altitudes on the island of Teneriffe in the years 1895 and 1896. Some of his measurements were made at the altitude of 3,700 meters, and give direct readings of solar radiation as high as 1.63 calories per square centimeter per minute. Angström declined to determine from these a value of the solar constant of radiation, recognizing that this demanded observations of the solar spectrum as well as pyrheliometric work. In later years he

prepared spectro-bolometric apparatus for this purpose, and made many solar constant measurements therewith at Upsala. These measurements are still being continued there by his successors. It is hoped that this long and interesting series will soon be published.

Passing from this work of Ångström, which belongs in a later period, and omitting mention of valuable pyrheliometric observations by numerous observers in Italy, Switzerland and Russia, which I regret that space forbids me here to discuss, attention must now be directed to the work of Langley, which marked an epoch in this kind of investigation.

LANGLEY'S OBSERVATIONS

Prior to Langley's observations there had been numerous attempts to determine the solar constant, which are well summed up in the excellent little book of Radau, entitled "Actinometrie." It is shown that nearly all observers were in comparative agreement, so far as their actual observations go, and if the transmission of radiation by the atmosphere be estimated by the simple formula

$$A = A_0 p^{B/760 \sec z},$$

which was employed by Pouillet and many others, the value of the solar constant would be found in the neighborhood of 1.75 calories.

But Forbes, Desains, Violle, Crova and others showed convincingly that this equation does not accurately express the diminution of radiation attending the decline of the sun from zenith to horizon, or the descent of the observer from a high altitude to a lower one. Accordingly several empirical formulæ of more complexity were proposed, which, owing to their more numerous constants, could be made to fit the observed variation of the total intensity of radiation under different conditions more closely. By the aid of such empirical formulæ higher values of the solar constant have been obtained. Some of these in our own time have gone as high as 4 calories. Radau however says:

> It is clear that the intensity of the solar radiation outside the atmosphere can not be certainly obtained from experiments which have been made [prior to 1871], for the result depends essentially on the manner of calculation.

This conclusion is still applicable to pyrheliometer measurements not supported by spectrum observations.

The tendency toward high values of the solar constant was powerfully stimulated by the publication of the report of the Mount Whitney expedition by Langley in 1884. As Forbes and Radau had stated, so Langley emphasized and acted upon the fact that the formula

$$A = A_0 p^{B/760 \sec z}$$

applies only to a homogeneous bundle of rays in a pure atmosphere; and the intensity of solar radiation outside the atmosphere can only be exactly determined when the atmospheric transmission coefficients of the rays of all wave-lengths, which go to make up the complex beam of the sun, are separately determined and allowed for. Langley was the first to determine and apply atmospheric transmission coefficients for numerous rays of different wave-lengths in the solar spectrum. For this purpose he invented the bolometer, a delicate electrical thermometer, and observed with it the variation of the intensity of each ray of the spectrum from low sun to high. He found it impracticable to determine the transmission coefficients in the water vapor bands of the infra-red, but assuming that there were no water vapor bands in the solar spectrum outside our atmosphere, he avoided this difficulty by smoothing the spectrum energy curve, which he computed from his bolometric observations to repre-

sent the distribution of solar radiation outside the atmosphere, so as to leave no water vapor bands in it at all. Had Langley stopped with these steps accomplished, he would have left us, as the result of the Mount Whitney expedition, 2.060 calories, the mean value as determined by high and low sun observations at Lone Pine, or 2.220 calories, the mean value similarly determined from observations at Mountain Camp. But, by the train of reasoning given on pages 142–144 of his report, he convinced himself that the exponential formula does not hold for the earth's atmosphere, even for a strictly homogeneous ray. He therefore altered his results by two different procedures, one of which he states was of a kind to give too low a value of the solar constant, and the other too high. By this means he obtained the values 2.630 and 3.505. The mean of these, 3.068, or in round numbers 3.0 calories per sq. cm. per min., he adopted as the solar constant. But in fact, both procedures were calculated to give too high results, and the most probable results of Langley's observations lies below either of them, and is in fact 2.22, or 2.06 calories, according as the work at Lone Pine or Mountain Camp is regarded as the better. In order to recognize this, it is necessary to examine the argument which led him to doubt the accuracy of the exponential formula, as applied to the transmission of homogeneous rays through the earth's atmosphere, but first let us consider the basis of the formula.

We have seen that Bouguer's formula rests on the fundamental assumption that the light is not changed in its nature in passing from one layer to another, so that equal layers take out equal fractions. This is not the case except for homogeneous rays. It is therefore necessary to divide the beam up into parts, each containing rays of approximately homogeneous transmissibility. For this purpose it is necessary to observe the spectrum of the sunlight by the aid of the bolometer or other satisfactory delicate heat-measuring instrument. Even so, it is not possible to observe the transmission of the atmosphere at every wave-length, so as to determine the coefficients of transmission in the fine lines of absorption by water vapor and oxygen which are introduced by the earth's atmosphere. These lines are mainly grouped in the great bands made up of these fine lines which occur in the red and infra-red spectrum, and for them a special procedure must be adopted as was introduced by Langley. In general, however, the bolometer suffices to give us atmospheric transmission coefficients in sufficient number to deal with the gradually changing transparency of the air for rays of nearly adjacent wave-lengths. The proof of the formula for atmospheric transmission for homogeneous rays follows: It will be seen that the formula is one of extrapolation solely, and is not applicable to computations of the transparency at different barometric pressures, unless it be the fact (which is not usual) that the quality of the air from the different stations to the limit of the atmosphere is approximately identical. This indeed may be the case at very high elevations of 4,000 meters and over, but is not the case for ordinary observing stations, so that in the use of the formula of transmission it is generally erroneous to introduce the barometric pressure in the exponent as was done by Pouillet.

PROOF OF FORMULA FOR TRANSMISSION

Imagine the atmosphere to be made up of n concentric layers so chosen in thickness as to produce separately equal barometric pressures, and let the number n be so great that the transparency of any single layer is sensibly uniform, although the layers may differ from each other in trans-

parency by any gradual progression. The index of refraction of air is so near unity that there will be no sensible regular reflection in passing from one layer to the next, and the transmission of each layer may be expressed exponentially by Bouguer's formula, but with different coefficients of transmission for the several layers.

Thus, suppose E_0 to be the original intensity of a beam of light incident upon the outermost layer at the angle whose secant is m.

Then after passing successive layers the remaining intensities become

$$E_1 = E_0 a_1^{m_1}, \quad E_2 = E_0 a_1^{m_1} \cdot a_2^{m_2},$$
$$E_n = E_0 a_1^{m_1} a_2^{m_2} \ldots a_n^{m_n}. \quad (1)$$

The value of the secant of the angle of incidence will change slightly in passing from layer to layer from two causes: first, the curvature of the earth; second, the refraction of the beam in air. These causes produce opposite effects, the first tending to increase the angle of incidence, the second tending to diminish it as the beam approaches the earth's surface. Their combined effect is dependent on the height to which the temperature exercises absorption and on the distribution of density with the height. But it is generally supposed that the absorption of the air above 40 miles from the earth's surface is negligible, and, remembering that the atmospheric density diminishes with the height, it appears that for zenith distances less than 70° the effect of change of the secant of the angle of the incident beam from the outermost to the innermost layer of the atmosphere will not introduce error greater than 1 per cent. Accordingly for zenith distances less than 70° we may write approximately

$$E_n = E_0 (a_1 a_2 \ldots a_n)^m. \quad (2)$$

The symbols $a_1, a_2 \ldots a_n$ denote constants (providing no change of transparency occurs during the interval of time in question), and their values are slightly less than unity. We may substitute for their product a single constant, a, itself a proper fraction, and remembering that E_n is the intensity at the earth's surface, above denoted simply by E, we have

$$E = E_0 a^m. \quad (3)$$

LIMITATIONS OF FORMULA

No mention is made in this expression of the barometric pressure, but it is easy to see that an alteration of barometric pressure would signify, under the conventions adopted in deriving the formula, a change in the number of layers, n. This would cause an alteration of the quantity a, which is the continued product of the transmission coefficients of the layers, by introducing additional multipliers $a_{n+1}, a_{n+} \ldots$ or by the withdrawal of some $a_{n-1}, a_{n-1} \ldots$ Since we have no means of determining the value of the terms so introduced or taken away, there is no means of correcting for change of barometer in the use of the expression (3) and it would, for instance, be impossible to compute, from knowledge of the values of E, E_0, a and m for one station, what would be the value of E at some station of different barometric pressure.

From this we see that the unit of air mass to be taken for each station is the air mass traversed by beams from zenith celestial objects *between the station itself and the outer limit of the atmosphere,* and that the barometric pressure can not be employed in the computation to reduce observations at different stations to a common unit of air mass.

The determination of the solar constant of radiation, based upon the demonstration which has just been given, depends upon the following assumptions:

1. In a homogeneous medium, a homogeneous ray loses a fixed proportion of its intensity in every equal length of its path.

2. The earth's atmosphere may be considered as made up of a great number of layers concentric with the earth, each approximately homogeneous in itself over the area swept through by the solar beam between zenith distances of 70° and 30° during the time required for this sweep of the beam.

3. Surface reflection of the outer boundary of the atmosphere, or the boundaries of its internal layers, is negligible.

4. Except in the known red and infrared atmospheric bands, the transparency varies gradually from wave-length to wave-length, or if atmospheric absorption lines exist, the energy they absorb is inconsiderable.

5. Atmospheric bands do not exist in the solar spectrum outside the atmosphere.

6. The quantity of solar energy beyond $\lambda = 0.3\,\mu$ in the ultra-violet and beyond $\lambda = 3.0\,\mu$ in the infra-red is inconsiderable.

The soundness of these assumptions is best proved by the results of a great number of observations made at sea level and at high altitudes during the last ten years by different observers, but mainly by the staff of the Astrophysical Observatory of the Smithsonian Institution.

DISCUSSION OF LANGLEY'S SOLAR CONSTANT VALUE

With this preliminary we may perceive why the high solar constant value of Langley ought not to be accepted. For this purpose consider lines 26 to 43 of page 144 of the Mount Whitney report, which detail the precise method employed in obtaining what Langley regarded as a minimum value, namely 2.63 calories per square centimeter per minute.

We now proceed to determine from our bolometer observations a value which we may believe from considerations analogous to those just presented, to be a *minimum* of the solar constant, and one within the probable truth. All the evidence we possess shows, as we have already stated, that the atmosphere grows more transmissible as we ascend, or that for equal weights of air the transmissibility increases (and probably continuously), as we go up higher. In finding our minimum value we proceed as follows, still dealing with rays which are as approximately homogeneous as we can experimentally obtain them. Let us take one of these rays as an example, and let it be one whose wave-length is $0.6\,\mu$ and which caused a deflection at Lone Pine of 201. The coefficient of transmission for this ray as determined by high and low sun at Lone Pine and referred to the vertical air mass between Lone Pine and Mountain Camp is 0.976. From the observations at Lone Pine then, the heat of this ray upon the mountain should have been

$$201 \times 1{,}000 \div 976 = 206.0,$$

but the heat in this ray actually observed on the mountain was 249.7, therefore multiplying the value for the energy of this ray outside the atmosphere, calculated from Mountain Camp high and low sun observations (275) by the ratio 2497/2060 we have 333.3, where 333.3 represents the energy in this ray outside the atmosphere as determined by this second process. In like manner we proceed to deal with the rays already used, thus forming column 8 in Table 120.

It is evident that the transmission coefficient determined for the wave-length $0.6\,\mu$ by the aid of high and low sun observations at Lone Pine, represented the mean transmission of a ray of this wave-length through a mass of air containing all the kinds of strata between Lone Pine and the limit of the atmosphere. Such a transmission coefficient would certainly be greater than that which would have been found if the air had all been like that between Lone Pine and Mountain Camp, because the lower layers are least transparent,[3] therefore the value 0.976 could be known, *a priori, not* to represent the transmission of the air between Lone Pine and Mountain Camp, but to be certainly greater than the true transmission coefficient for the air between these stations. Accordingly the discrepancy between the computed and observed intensities at Mountain Camp is only what should be expected, and implies no failure of the formula of Bouguer at all; for that formula was used in the computation of the intensity at Mountain Camp just quoted with a coefficient p which was certainly wrong. The argument on which Langley acted may be stated in a plausible form as follows: If Bouguer's exponential formula with the transmission coefficient obtained by high and low sun observations at Lone Pine gives too low a value of the intensity of homogeneous solar radiation for a station within the atmosphere like Mountain Camp, as was shown by actual observation, much more will it

[3] See Table 118 of the Mount Whitney Report.

give too low a value outside the atmosphere. An equally plausible, and equally fallacious argument is the following: It is said that the density of water decreases with increasing temperature at the mean rate of about .00041 per degree from 0° to 100°. Hence its density at 4° should be 0.99836, but observations at 4° prove that water is actually denser at this temperature than at 0°, therefore the supposed decreased density at 100° is a delusion.

SOLAR CONSTANT WORK OF THE SMITHSONIAN ASTROPHYSICAL OBSERVATORY

The earlier years of the work of the Astrophysical Observatory were devoted to the improvement of the bolometer and the use of it for the determination of the positions of lines in the infra-red solar spectrum. About 1902 attention began to be devoted to measurements of the solar constant of radiation. We approached these measurements with a very much better instrumental equipment than that which had been Langley's in the Mount Whitney expedition of 1881. Soon after the Astrophysical Observatory was founded, about the year 1890, Langley introduced the automatic registration of the galvanometer in connection with the spectro-bolometer, and in the subsequent years the difficulties connected with the use of the recording spectro-bolometer were so far overcome that the solar spectrum could be observed from the extreme ultra-violet end of the spectrum at about $0.3\,\mu$ to a wave-length of about $3\,\mu$ in the infra-red with great ease and accuracy, in an interval of 8 minutes of time. Drift of the galvanometer, which in Langley's expedition to Mount Whitney he has told me often amounted to a meter a minute on the scale, was now so far reduced that a centimeter an hour would be unusual. In fact the bolometer, despite its great sensitiveness, is about as easy to use for this work as an ordinary thermometer is for measuring the temperature of the air.

Our first measurements of the sun's radiation as a whole were made with the Crova alcohol actinometer, and in order to standardize this instrument we constructed a modified Tyndall pyrheliometer consisting of a copper box filled with mercury and having a cylindric bulb thermometer inserted radially into the box. Owing to the difficulty of keeping the small thread of mercury at the proper point for reading purposes in the Crova actinometer, we found it more desirable to develop the pyrheliometer for our purpose. Soon a solid disk of copper with a radial hole large enough to enclose the thermometer bulb was substituted for the box filled with mercury, the use of mercury being limited to insuring a good heat connection between the bulb of the thermometer and the copper of the disk. Some of these copper disk pyrheliometers are still in use on Mount Wilson. About 1909, however, the further improvement was introduced of using silver in place of copper for the disk. A thin steel lining is provided for the hole where the thermometer is inserted, so as to prevent the mercury from alloying with the silver. In these silver disk instruments the thermometer stem, which is introduced radially in the disk, is bent outside the chamber at right angles so as to point towards the sun. The whole instrument is mounted equatorially with a device for moving it by hand to follow the sun from moment to moment. These disk pyrheliometers, either of copper or silver, have now been in use since the year 1906 with great satisfaction. Their constancy over long periods of time leaves nothing to be desired, and the accuracy of observation reaches a small fraction of 1 per cent.

As the disk pyrheliometer is a secondary instrument, it was necessary to develop a

standard primary instrument to compare it with. As early as the year 1904 experiments were begun to produce a pyrheliometer based upon the hollow chamber "black body" type, with a flowing liquid to carry off the heat produced by the absorption of the solar rays within such a chamber. After numerous experiments and long trial the waterflow standard pyrheliometer was fully developed in the year 1910. Later still, another hollow chamber instrument in which the chamber is bathed with stirred water was employed to check the results of the standard water-flow instruments. In each of these types of standard instruments it is possible to introduce electrically known quantities of heat for testing purposes, and in many experiments it has been proved that the test quantities of heat thus introduced may be recovered to within 1 per cent. Accordingly it is believed that the standard scale of radiation has been thoroughly established. The silver disk instruments are standardized by comparing them with such standard instruments, and the standard scale of radiation so produced, which is believed to be accurate to at least ½ of 1 per cent., has been diffused generally over the world by the Smithsonian Institution. About 25 copies of the silver-disk pyrheliometer have been standardized and sent out to Europe, North America and South America for this purpose. The Smithsonian instruments read about 3.5 per cent. above those of Ångström.

Measurements of the solar constant of radiation were begun in Washington in the year 1902 and have been continued at Washington and elsewhere in every succeeding year until the present time. In 1903 it was noticed that the values of the solar radiation outside the atmosphere obtained in Washington were distinctly variable within the limits of about 10 per cent., and as some of the changes appeared to occur between days which were of the highest order of excellence, it was thought possible that these changes might occur in the sun, and not be caused by alterations of the transparency of the earth's atmosphere. To test this possibility, a station was established on Mount Wilson, California, in the year 1905 by invitation of Director Hale of the Mount Wilson Solar Observatory. The station proved to be very favorable for the work, and in 1908 a permanent structure of cement was built there for the use of the Smithsonian Astrophysical Observatory. In the years 1909 and 1910 spectro-bolometric observations for the determination of the solar constant of radiation were also made on the extreme summit of Mount Whitney in California at an altitude of 4,420 meters. At the same time observations were being made at Mount Wilson at an altitude of 1,730 meters. The results from these two stations reduced to outside the atmosphere at mean solar distance, like those which had formerly been obtained simultaneously at Washington and Mount Wilson, were identical within the limit of the accuracy of the determinations. The accuracy of the work at Mount Wilson and Mount Whitney was so great that the average divergence between the observations of the same days was only 1 per cent. At Washington the sky conditions being less perfect, the average divergence from simultaneous solar-constant results of Mount Wilson was about 3 per cent.

EVIDENCES OF SOLAR VARIABILITY OF SHORT IRREGULAR PERIODS

Numerous observations of several years at Mount Wilson indicated a fluctuation in the solar constant values having a range of about 10 per cent. The fluctuations seemed to occur irregularly, sometimes running their course of 10 per cent. or less

within the period of a week or ten days, and at other times keeping nearly constant. It had been shown by the observations made simultaneously at Mount Wilson and at Mount Whitney that the results as reduced outside the atmosphere appear to be independent of the altitude of the observing station on days when the sky conditions appeared to the eye to be excellent. The march of the apparent fluctuation of the solar constant values at Mount Wilson has not been of a hap-hazard character. I mean by this that the values would progress in a definite direction, as for instance from a low value to a high value by steps through several successive days, and then as definitely progress in the opposite direction through other successive days, and do not fluctuate widely from high values to low as would be the case if the irregularities were due merely to instrumental error. Since, then, it appeared that the fluctuations were neither of an accidental instrumental character nor of a character associated with the altitude of the observing station, it appeared most reasonable to conclude that these fluctuations were due to changes in the sun's emission.

To test this important conclusion it appeared necessary to establish a second station, equally favorably situated with regard to sky conditions as Mount Wilson, but so far remote from Mount Wilson that local influences could not be expected to alter the results at both stations in the same direction on the same day. Such a station was established at Bassour, Algeria, in the years 1911 and 1912. Seventy-five days of simultaneous measurement at Mount Wilson and at Bassour were obtained, and of these days about 50 were so far free from the occurrence of clouds or other disturbing influences at *both* stations as to be retained for purposes of comparison. The result of the comparison shows that when high values are obtained at Bassour, high values are obtained also at Mount Wilson and *vice versa*. Thus the fluctuations which have been found appear to be truly existing in the solar radiation outside the earth's atmosphere, for the solar constant values obtained at two stations separated by about one third the circumference of the earth unite in showing them.

VALUE OF THE SOLAR CONSTANT

During the whole solar constant campaign from 1902 to 1913, about 700 measurements of the solar constant of radiation have been obtained, all but three of the values ranging between 1.80 calories and 2.10 calories. The range of these numbers is mainly attributable to the actual fluctuation of the sun itself, though part, especially in Washington work, is due to accidental errors of measurement. The mean value from 690 measurements is 1.933 calories per square centimeter per minute. It is believed that this number represents the average value of the solar constant of radiation for the epoch 1902 to 1913 within 1 per cent. There is still the possibility, however, that an appreciable quantity of solar radiation beyond the wave-length of 0.3μ in the ultra-violet has been absorbed by ozone in the higher atmosphere of the earth, and has been impossible of determination at the stations employed. However, from the consideration of the form of energy curve of the sun's spectrum it is improbable that this lost ultra-violet radiation can exceed 1 or 2 per cent.

SOLAR VARIABILITY ASSOCIATED WITH SUN-SPOTS

Besides the short irregular fluctuation of solar radiation above mentioned as having been shown by the simultaneous measurements at Mount Wilson and Bassour,

Algeria, it appears that a long period fluctuation is associated with the sun-spot numbers. This connection is brought out by taking the mean monthly values of the solar constant measurements at Mount Wilson from the year 1906 on, and comparing them with the mean monthly sun-spot numbers of Wolfer for the same period. From such a comparison it appears that the greater number of sun-spots the higher will be the solar constant of radiation, and that an increase of a hundred sun-spot numbers corresponds to an increase of about 0.07 calories per square centimeter per minute in the solar radiation outside the earth's atmosphere. This is a very curious circumstance, when it is recalled that the temperature of the earth is generally lower at sun-spot maximum than at sun-spot minimum, notwithstanding that, if the above result be true, the solar radiation is more intense at sun-spot maximum than at sun-spot minimum. On the other hand, the result is in line with the irregular variability of the Myra type of variable stars.

ATMOSPHERIC TRANSMISSION

In connection with the measurements which have been made of the solar constant of radiation, there have been some interesting by-products. Among these we may mention first the determination of the transmission coefficients of the earth's atmosphere for light of all wave-lengths, including the ultra-violet and the infra-red spectrum, and ranging from wave-length 0.3μ in the ultra-violet to wave-length 2.5μ in the infra-red. These transmission coefficients have been obtained by the Smithsonian observers at Washington, Mount Wilson, Mount Whitney and Bassour. It is very interesting to compare them with the transmission of the atmosphere as computed according to the theoretical consideration of Rayleigh on the cause of the light of the sky. It is found that by means of these observed transmission coefficients the value of the number of molecules in the atmosphere may be obtained almost as accurately as by the use of the more common laboratory methods for determining the number of molecules per cubic centimeter of a gas of known density. It is found that the theory of Rayleigh connecting the change of transmission with the wave-length is closely confirmed by the observations at Bassour, Mount Wilson and Mount Whitney. Similar measurements of atmospheric transmission for more limited regions of the spectrum have been made by other observers at high altitudes, and these also are found to agree closely with the theory of Rayleigh, and with our own observations.

Not less interesting is the determination of the distribution of energy in the sun's spectrum, and thereby of the probable temperature existing in the sun. The solar temperatures may be inferred also from the value of the solar constant of radiation itself, and the two methods agree substantially in giving the probable solar temperatures as between 6,000 and 7,000 degrees absolute centigrade.

RECENT BALLOON EXPERIMENTS

Notwithstanding the satisfactory state of the theory of solar constant measurements by the method of Langley, depending upon spectro-bolometric observations at high and low sun combined with measurements by the pyrheliometer, and notwithstanding the close agreement between results obtained by this method for many years at stations of differing altitude from sea-level to 4,420 meters elevation, there still exists the possibility that if we could, indeed, go outside the atmosphere altogether we should obtain values differing materially from those above given. So

long as we observe at the earth's surface, no matter how high the mountain top on which we stand, the atmosphere remains above us, and some estimate must be made of its transmission before the solar constant can be determined. Different persons will differ in the degree of confidence which they will ascribe to measurements of the atmospheric transmission, such as have been considered, and there are still some who totally disbelieve in the accuracy of the results thus far obtained, even though they be confirmed by observations at such differing altitudes. Accordingly it has seemed highly desirable to check the results by a method of direct observation by the pyrheliometer, attaching the instrument for this purpose to a balloon and sending it to the very highest possible altitudes. By a cooperation between the Smithsonian Institution and the United States Weather Bureau, experiments for this purpose were made in July and August of the year 1913.

The instruments employed were modified in form from the silver-disk pyrheliometer, which has been described above. As the apparatus could not be pointed at the sun the disk was placed horizontally, and the thermometer was contrived to record its temperature by photography upon a moving drum. The receiving disk was alternately exposed to the sun and shaded by the intervention of a shutter, operated intermittently by the clock work which rotated the drum under the stem of the thermometer. Five instruments of this kind were sent up on successive days. While it was well known that the temperature of the higher air would go as low as —55° C., it was believed that a blackened disk exposed half the time to the direct sun rays, would certainly remain above the temperature of —40°, which is the freezing point of mercury. This expectation was disappointed. Accordingly, owing to the freezing of the mercury in the thermometer, the highest solar radiation records obtained during the expedition were at the altitude of 13,000 meters, although the balloons in some instances reached the altitude of 33,000 meters.

The results obtained, while they have not the same degree of accuracy as those obtained by direct reading of the silver disk pyrheliometer, are yet of considerable weight. All the measurements unite in indicating values of the solar radiation at altitudes of 10,000 meters and higher, which fall below the value of the solar constant of radiation as obtained by other methods, and above the value of the radiation at the summit of Mount Whitney as obtained by different observers with pyrheliometers. It is expected in the coming year to repeat the observations with balloons under much improved circumstances. By aid of electrical heating apparatus it is expected to keep the surroundings of the disks at approximately the freezing temperature, even though exposed to the air at temperatures as low as —55° C. In this way it is hoped to obtain good pyrheliometer measurements as high as it is possible for sounding balloons to go, and possibly to an altitude of 40,000 meters. As the atmospheric pressure at such altitudes is less than 1 per cent. of that prevailing at sea level, the experiments, if successful, may be expected to remove reasonable doubt of the value of the solar constant of radiation.

C. G. Abbot

SETH CARLO CHANDLER

Dr. Seth Carlo Chandler, eminent astronomer, died on December 31, 1913, in his sixty-seventh year after a short attack of pneumonia.

Born at Boston, Mass., September 17, 1846,

the son of Seth Carlo and Mary (Cheever) Chandler, he spent his early childhood in and around Boston. He attended the English high school at Boston, graduating in 1861, but did not pursue a collegiate course as he had already become interested in mathematical computations while still at the high school, being employed upon the computations of Professor Benjamin Peirce. After graduation he joined Dr. B. A. Gould as private assistant and thus obtained his first taste for astronomical subjects. Dr. Gould was at that time busily engaged in developing the longitude-determinations of the Coast Survey, and through him Dr. Chandler joined the U. S. Coast Survey as aid in 1864. Later when Dr. Gould made his historic expeditionary trip to the Argentine Republic, which eventually resulted in the establishment of a national observatory by the Argentine government, Dr. Chandler refused an offer to accompany the expedition in favor of a position as actuary with the Continental Life Insurance Co. of New York, removing to New York City. It was shortly after this that he married Miss Caroline M. Herman, of Boston, on October 20, 1870.

Seven years later he returned to Boston to accept a position as consulting actuary for the Union Mutual Life Insurance Co. of Boston.

But though his life had been thrown into other channels, Dr. Chandler still felt an interest in astronomical subjects, so it was not surprising that with Harvard College Observatory so near at hand, he should have joined the work of the observatory. Astronomers had long felt the need of some system of communicating such discoveries as comets in order that such objects might not be lost through the inability to observe them at any one station. Realizing this need, Dr. Chandler and Mr. John Ritchie formulated a code for the speedy transmission of discoveries by telegraph to observatories all over the United States. Though the system has been revised, it is still being operated by the Harvard College Observatory.

It was during his connection with Harvard College Observatory that Dr. Chandler invented and constructed the almucanter, an instrument for measuring stellar positions.

After the year 1886 he became a private investigator. There are many instances of men who, while deriving their source of income from other professions, have become interested in astronomy, and who have accomplished remarkable results; but among these there is none to compare with Dr. Chandler, whose whole soul seemed wrapped up in his astronomical investigations.

When one considers that he was the author of over two hundred articles, it can readily be imagined what a serious interest he took in his chosen field, and what a hard worker he was. It has been remarked of many authors that they have only written when the spark of genius inspired them. So it was with Dr. Chandler, who at times would take an almost complete rest from his astronomical labors, only to enter one orgie after another of concentrated effort. While under the spell of one of these sieges, nothing could divert him, but once over it he was ready for any form of diversion or entertainment, taking a great interest in many outside affairs.

As an astronomer Dr. Chandler will possibly be chiefly remembered for his work upon variable stars, and for his historic discovery of the variation of latitude. As a result of his discovery of the variation of latitude, international latitude stations have been established at different points of the earth in order to study the periodic shifting of the earth's pole. Dr. Chandler treated a great variety of other subjects with thoroughness.

For his brilliant work he received the Watson medal of the National Academy of Sciences in 1895, and in 1896 he received the gold medal of the Royal Astronomical Society. De Pauw granted him the degree of LL.D. in 1891.

Upon the death of Dr. Gould, founder and first editor of the *Astronomical Journal*, Dr. Chandler assumed the editorship, which he held during the period 1896–1909, resigning at the latter date because ill health prevented

him from performing his editorial duties. Until his health broke down he had devoted not only much time to the *Astronomical Journal,* but considerable aid from his private purse, a truly conclusive proof of his great interest in the *Journal.*

Personally Dr. Chandler was a man of large interests and a ready sympathy. Those who knew him will remember with pleasure his entertaining and brilliant conversation and correspondence. He was possessed of a broad sense of humor and a keen wit, at once a source of delight to his friends and a weapon to be shunned by his enemies.

BENJAMIN BOSS

DUDLEY OBSERVATORY

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

REPORT OF THE ASSOCIATE SECRETARY FOR THE SOUTH

THE associate secretary entered upon his duties October 1, 1913. The first work was to prepare a circular letter which was forwarded to each of the 538 members of the association then residing in the territory of the thirteen southern states assigned by the permanent secretary. The text of this letter follows:

Dear Sir: The next annual meeting of the American Association is to be held at Atlanta, Ga., from December 29, 1913, to January 3, 1914.

To insure its success every member must cooperate.

We desire a large attendance and full programs. This is your opportunity to show your loyalty to the Association and your interest in its aims. Make it a point to be present and to participate in the discussions.

The Association has not the membership in our section which it should have. There has never been a time when the active cooperation of scientists was of such importance as it is to-day. The need of such cooperation is especially marked in the South. We need to get together, to exchange views and to stimulate scientific work. We need to exert our collective influence to secure better support for scientific activities, and greater discrimination in the filling of scientific posts.

The Atlanta meeting of the American Association offers an opportunity for southern men of science to show the country at large that a progressive spirit animates our section and that the cause of higher education and scientific research is being fostered among us.

Will you not constitute yourself a committee of one to secure new members and promote the Association's interests this year?

Enclosed are several membership application cards. Others will be supplied on request. Please make an effort to secure new members from among your colleagues, and urge their attendance at the meeting.

A stamped envelope is enclosed for your reply. I shall be glad to address personal letters to any individual whom you may suggest as eligible to membership. Please also make suggestions as to methods of procedure in advancing the work of the Association in your section.

Let each one do his part and the advancement of science in the South will be materially furthered by the Atlanta meeting.

Cordially yours,
Associate Secretary

With this letter there were enclosed two membership application cards and a stamped return envelope.

In addition a list of 37 members was selected from the representative colleges and universities of the southern states. To each of these a special letter was sent, the text of which follows:

Dear Professor: I am endeavoring to assist Dr. Howard in connection with the Atlanta meeting of the American Association, and I wish to request your personal cooperation.

It is unnecessary to urge upon you the importance of the American Association for men of science, and the obligation which rests upon us in the South to make the coming meeting a success. But if we would demonstrate to the other sections of the country that the South takes an active interest in the advancement of science, we must energetically encourage our colleagues to attend the Atlanta meeting.

I am addressing a circular letter to each southern member of the Association, a copy of which I enclose. But I wish to ask of you special assistance in your own institution.

[1] Presented to the Council at the Atlanta meeting.

I find that the following members of your faculty are enrolled in the Association: ———. Will you not mention to each of these the importance of the Atlanta meeting and urge his attendance and participation?

There are doubtless many others in your community who are eligible to membership. We should like to receive all whom you can recommend, and to welcome them at Atlanta. I enclose several membership application cards and will send others on request.

If you will suggest their names, I shall be glad to write them individually, or, if you think it advisable, I can visit your institution at some time in the fall which we can agree upon, for the purpose of interviewing these men personally, and possibly to speak before the men of science in your community.

Will you not write to me in regard to the matter, and let me know just what you think may be the best method for interesting the present members, and increasing the roll from your institution?

Very cordially yours,
Associate Secretary

From these 538 communications 120 replies were received. Of the special letters 24 were acknowledged. Of the total number of replies 44 recommended persons for membership.

The following table indicates the distribution of members and the acknowledgments received.

State	Total Number	Total Acknowledgments	Number Submitting Names for Membership
Alabama	31	9	5
Arkansas	11	3	2
Florida	27	2	0
Georgia	59	15	7
Kentucky	29	3	1
Louisiana	47	7	3
Mississippi	18	9	4
North Carolina	38	12	3
South Carolina	27	8	3
Tennessee	51	19	6
Texas	83	14	3
Virginia	86	10	5
West Virginia	28	6	2
Removed from territory	3	3	0
	538	120	44

Letters of invitation were sent to each person thus suggested for membership in the association. This number was greatly augmented by the names of eligible persons otherwise secured. The total number of such invitation letters was 255. A membership application card and return envelope were enclosed with each letter, also one of the association leaflets of information.

Acceptances were received from 37 to whom these invitations were extended. In addition, 22, who may or may not have been influenced by these communications to members, applied directly to the permanent secretary. The total enlistment for the territory was therefore 59.

These were distributed by states as follows:

Ala.	6	N. C.	4
Ark.	0	S. C.	7
Fla.	2	Tenn.	14
Ga.	4	Texas	8
Ky.	1	Va.	5
La.	5	W. Va.	3
Miss.	0	Total	59

The associate secretary made two trips in the interests of the association. On October 31 the meeting of the Southern Educational Association at Nashville was attended. On invitation of the president, Hon. M. L. Brittain, the secretary addressed a general meeting of the association, urging the cooperation of southern educators in the work of the American Association for the Advancement of Science, and extending a cordial invitation to be present and participate in the Atlanta meeting.

In response to the requests received from institutions, a ten-day trip was undertaken, commencing November 30, during which the following colleges and universities were visited:

University of Mississippi,
Miss. A. and M. College,
Ala. Polytechnic Institute,
Georgia School of Technology,
University of Georgia,
Davidson College, N. C.,
Clemson College, S. C.

At all these, excepting Davidson College, an address was made before the faculties of the institutions. The topic chosen for discussion was that of cooperation among scientists.

The remarks were informal, dealing with various aspects of scholarly work, and the great need of a more active interest in the advancement of science in southern institutions. These gatherings were all well attended and the discussion led in several places to an active participation on the part of various members of the faculties concerned.

In view of the efforts made by the association to stimulate a greater interest in scientific advancement in the south, the results of this campaign have not been as encouraging as they should be. In the opinion of your secretary there are various reasons for this condition of affairs, but too much space would be required to consider them here at any length. A few points may, however, be mentioned to indicate the general status of science in southern colleges and universities:

1. Outside the agricultural experiment stations, scientific research is not usually encouraged. There is a widespread notion that research and teaching are inimical. Since few southern institutions can afford the luxury of men engaged primarily for research, it is commonly agreed to dispense with this feature of higher education and concentrate upon the employment of "good teachers."

2. The teaching hours of the faculties are often considerable. Almost never are they short of 15 periods per week, and sometimes they run as high as 40. The large number of different courses which one man is thus required to undertake, to say nothing of his participation in committee work of various sorts, leaves him with neither energy nor time for research.

3. The salaries paid to professors are usually inadequate. The men are thus unable to get away to graduate institutions on sabbatical leave or during the summer for special work in their respective fields.

4. There is little active competition in the filling of vacancies, since the openings are infrequently made public before the positions are filled. Furthermore, the compensation of full professors is commonly uniform, hence there is no stimulus within the institution for advancement of salary in recognition of activity along research lines.

5. The instructors and younger men of the faculties are often recruited from recent graduates who have had little experience in advanced work and often have not definitely determined upon a university career. They therefore lack the stimulus of advancement in their profession through original work, and fail to appreciate the value of national gatherings of scientific men, as providing inspiration, and affording an opportunity for personal contact with men in their own lines of endeavor.

Respectfully submitted,
R. M. Ogden

December 30, 1913

MINUTES OF THE SECOND MEETING OF THE PACIFIC COAST COMMITTEE

The committee met on February 7, 1914, in Parlor B of the Palace Hotel, San Francisco.

Present: Chairman Campbell, President Branner, Mrs. Moody, Dr. MacDougal, Professors Haskell, Jenkins, Kellogg, Kofoid, Kroeber, Lawson, Leuschner, E. P. Lewis, Martin, Merriam, Sanford, Setchell, Stillman; Professor Louderback representing the Pacific Association of Scientific Societies, and Commissioner Barr representing the Panama-Pacific Exposition.

It was voted that ten should constitute a quorum.

The minutes of the last meeting, as printed in Science, were approved.

It was voted to strike out the word "Coast" in the designation "Pacific Division."

The report of the executive committee, presenting resolutions of policy, was discussed, and with some amendments, finally adopted as follows:

1. It shall be the purpose of the Pacific Division of the American Association for the Advancement of Science to promote the interests of science through formal and definite cooperation with all Pacific Coast scientific societies of good standards already in existence, and to organize sections in necessary lines of work for which no other provision has been made, such sections to be maintained only until the subjects shall be otherwise

provided for by the organization of affiliated societies.

2. The times and places of meeting of the division shall be decided by a committee consisting of a representative of the division and one representative of each of the affiliated societies.

3. The division shall organize or maintain no sections for the presentation of technical programs in the lines represented by affiliated societies. The technical programs shall be organized by the separate societies, with one member of the division council as a member of the program committee of each society.

4. Individual members of societies need not become division members, and division members need not join societies, but the privileges of those members belonging only to the division to present worthy papers in the proper programs and to take part in the discussions should be recognized.

5. All general sessions, public lectures, appointments of committees for general scientific purposes, etc., shall be controlled by officers of the Pacific division.

6. The constituents of the Pacific division shall be the individual members of the American Association for the Advancement of Science living in the territory defined by the original resolution establishing the Pacific division, and such constituent societies existing within this territory as are up to standard and which shall apply for membership and be accepted by the division, all societies at present constituents of the Pacific Association of Scientific Societies to have the privilege of affiliation until July 1, 1916.

The appointment of a subcommittee to draft a constitution for the Pacific Division was referred to the executive committee with power to act.

A special committee consisting of Director Campbell, Dr. MacDougal and Professor Merriam was appointed to select the associate secretary with power to act. (This committee met later in the day and appointed Albert L. Barrows to this position.)

Professor Lawson presented the report of the committee on the time and place of meeting. The report of the committee was finally adopted with some amendments as follows:

1. The American Association for the Advancement of Science should maintain a central office in San Francisco during the time of meeting.

2. The general sessions of the meeting should be held in San Francisco.

3. The evening lectures should be given in San Francisco.

4. The sectional meetings should be held chiefly in Berkeley.

5. There should be one day's session for sectional meetings at Stanford University.

6. The time of meeting should be the first week in August, 1915.

The chairman stated that Director Hale had declined the chairmanship of the committee on scientific program on account of his health, and that a new appointment would be announced later. (President J. C. Branner has since consented to become chairman of this committee.)

Adjourned to meet at the call of the chair.

E. P. LEWIS,
Secretary.

SCIENTIFIC NOTES AND NEWS

PROFESSOR J. H. COMSTOCK, of Cornell University, has received one of the twelve honorary memberships of the Société Entomologique of Belgium.

THE Franklin Institute of the State of Pennsylvania has awarded its Elliott Cresson gold medal to Professor Wolfgang Gaede for his molecular air pump, in consideration of the very great value of this invention for the quick production of vacua beyond those hitherto obtainable.

THE Cameron prize of the University of Edinburgh has been awarded to Professor Paul Ehrlich in recognition of his discovery of salvarsan and other contributions to medical science.

PROFESSOR ERNST NEUMANN, the pathologist of Königsberg, has been given an honorary doctorate of medicine at the University of Geneva on the occasion of his eightieth birthday.

M. HENRI BERGSON, professor of philosophy at the Collège de France, has been elected to membership in the French Academy.

PROFESSOR J. G. FRAZER has been elected a member of the Athenæum Club for "distinguished eminence."

Arrangements are being made for a reception and dinner in honor of Professor Ira O. Baker, '74, of the University of Illinois, at the Hotel LaSalle in Chicago, on March 17. About four hundred are expected to be present and the list of speakers will include some of the most prominent engineers of the west. Professor Baker completes in June, 1914, forty years of active, continuous service as a member of the faculty of the college of engineering of the University of Illinois.

Dr. Wolfgang Ostwald, professor of chemistry in the University of Leipzig, Germany, was given a banquet on February 11, by the Cincinnati Chemical Society and the Cincinnati Society for Medical Research.

Professor J. Paul Goode, of the University of Chicago, has completed the second pair of wall maps in the series upon which he has been engaged for some years. This pair consists of the physical and political North America. The first pair on the physical and political Europe were issued some months ago. There are to be eighteen maps in the series, all of which are nearing completion.

Lewis E. Moore, associate professor of structural engineering at the Massachusetts Institute of Technology, has resigned to become bridge engineer for the Massachusetts Public Service Commission.

Professor Hergesell, head of the Meteorological Institute of Strassburg, has been appointed director of the Aeronautical Laboratory at Lindenberg, in succession to Professor Assmann.

Professor A. A. Iwanow has been appointed director of the University Observatory at St. Petersburg.

Dr. Martin Strell has been appointed assistant in the Biological Experiment Station for Fisheries at Munich.

Professor E. C. Bryant, of Middlebury College, Professor L. L. Campbell, of Simmons College, and Professor W. E. McElfresh, of Williams College, are spending their sabbatical year at the Cavendish Laboratory of Cambridge University, and are carrying on researches under Sir J. J. Thomson.

Professor Henry Tschetschott, of the St. Petersburg Mining Institute, has registered at the Massachusetts Institute of Technology for special work. His coming to the institute is part of a general plan of the government to educate Russians abroad for positions as teachers in the home schools. Already there are at Technology two other Russians, Messrs. Penn and Ortin, who have likewise been sent by the government.

Dean Charles R. Bardeen, of the school of medicine of the University of Wisconsin, delivered the annual address of the University of Iowa chapter of Sigma Xi, February 18, on "The Effect of Physical and Chemical Agents on Development."

Under the auspices of the Rush Society, the College of Physicians of Philadelphia, the University of Pennsylvania, the Philadelphia Pathological Society, and the Mütter Museum, the Weir Mitchell lecture for 1914 was given on February 25, by Dr. Harvey Cushing, professor of surgery at the Harvard Medical School, on "Clinical types of dyspituitarism."

The Harvey Society lecture on February 28, at the New York Academy of Medicine, was given by Professor Richard P. Strong, of Harvard University, on the etiology of oroya fever and verruga peruviana.

"The Nebular Hypothesis" was the subject of an illustrated lecture given on March 2 by Professor Forest Ray Moulton, of the department of astronomy and astrophysics in the University of Chicago, at the Berwyn center of the University Lecture Association, Chicago. On March 16 Professor Moulton speaks at the same place on the subject of "The Sidereal Universe."

Dr. Wolfgang Ostwald delivered his series of five lectures on colloids at the Ohio State University during the week ending February 21. A more popular lecture designed to interest beginners in chemistry was delivered for the benefit of the freshmen class.

The foreign mathematicians who attended the Fifth International Congress of Mathematicians held at Cambridge in 1912 subscribed a sum to be devoted to a permanent

memorial to the late Sadlerian Professor, Dr. Cayley. We learn from the London *Times* that, having in mind that the presidency of this congress was the last public appearance of Sir George Darwin, his colleagues in the administration of the congress have desired to provide a memorial of his work in the same connection. Accordingly a brass plate with armorial decorations has been prepared, and is now offered by Sir Joseph Larmor on behalf of his colleagues to the university. It is proposed to fix this brass in the chief mathematical lecture-room in the new lecture-rooms building.

MR. H. B. WOODWARD, F.R.S., formerly assistant-director of the British Geological Survey, died on February 6, aged sixty-five years.

MAJOR G. E. H. BARRETT-HAMILTON died on January 17 in South Georgia, where he was conducting an investigation into the whaling industry on behalf of the Colonial Office and the British Natural History Museum.

DR. KARL BÖLCKERS, professor of ophthalmology at Kiel, has died at the age of seventy-eight years.

WE regret also to record the death of M. Alphonse Bertillon, the distinguished French anthropometrist.

THE Russian minister of public instruction has made a grant of $50,000 to the St. Petersburg Academy of Sciences to assist a search for radio-active minerals throughout the Russian Empire.

CANADA has established a forest products laboratory in connection with McGill University at Montreal, on the lines of the United States institution of the same sort at the University of Wisconsin.

PROVISION is to be made in connection with the French department of war for continuing the aerological work carried on by the late M. Léon Teisserenc de Bort, at his observatory at Trappes.

THE annual general meeting of the American Philosophical Society will be held on April 23, 24 and 25, 1914, beginning at 2 P. M. on Wednesday, April 23. Members are requested to send to the secretaries, at as early a date as practicable and before March 5, 1914, the titles of papers which they intend to present so that they may be announced on the *preliminary* program which will be issued immediately after that date and which will give in detail the arrangements for the meeting. Papers in any department of science come within the scope of the society which, as its name indicates, embraces the whole field of useful knowledge. The publication committee, under the rules of the society, will arrange for the immediate publication of the papers presented in either the *Proceedings* or the *Transactions*, as may be designated.

THE fifth International Congress of Philosophy will be held in London beginning on August 31, 1915, under the presidency of Dr. Bernard Bosanquet. The sections proposed are: (1) General Philosophy and Metaphysics. (2) Logic and Theory of Knowledge. (3) History of Philosophy. (4) Psychology. (5) Æsthetics. (6) Moral Philosophy. (7) Social Philosophy and Philosophy of Law. (8) Philosophy of Religion. All communications should be directed to the honorary secretary of the congress, Dr. H. Wildon Carr, More's Garden, Chelsea, London, S.W.

THE territory within a mile or two of each of the mouths of the Mississippi is characterized by large swellings or upheavals of tough bluish-gray clay, to which has been applied the name "mud lumps." Many of these mud lumps rise just offshore and form islands having a surface extent of an acre or more and a height of 5 or 10 feet, but some do not reach the water surface. These mud lumps, in addition to being of importance because of their effects on the channels of the Mississippi River, are also of considerable scientific interest, for their development is not included in the usual conception of delta growth, and although several theories have been advanced, their cause must still be regarded as uncertain. To an observer at the mouth of the river the idea that the region is a great dumping ground for a large part of the United States is most impressive. The land is being built out into the sea at an estimated average rate of about 300 feet a year; in some places the rate is much more rapid than in others. In

one place in Garden Island Bay the land appears to have advanced 2,000 feet in the spring of 1912. The mud lumps are commonly 20 to 30 rods broad and stand 20 or 30 feet above the adjacent bottom. Their growth occupies from a few hours to several years and is usually irregular. Generally a mud lump rises in a few weeks or months to a height of 4 or 5 feet above the surface of the water. Then it remains quiet and is beaten down by the waves in the course of a few years. Many of them subside, however, and some disappear over night. Those that rise slowly are considerably worn before they stop growing, while those that rise more rapidly and in protected places are capped by laminated silt having a maximum thickness of 10 feet. Among the most conspicuous and impressive features of the mud lumps are the mud springs that are active on many if not all of them. The discharge from these springs consists of salt, watery mud and gas—in fact, gas escapes at many places on the surface of the Delta of the Mississippi, the vents appearing to be most numerous and largest on and near the mud lumps, though the rate of flow rarely, if ever, exceeds a few cubic feet an hour. Gas rises in bubbles in all the mud springs, though its rate of issue varies. The United States Geological Survey has issued a report entitled "The Mud Lumps at the Mouths of the Mississippi," by Eugene Wesley Shaw—a copy of which may be obtained free on application to the director of the survey, Washington, D. C.

UNIVERSITY AND EDUCATIONAL NEWS

The observance of Washington's birthday at Lehigh University was marked by the dedication of Coppee Hall, the new home of the arts and science department. The building is named after Dr. Henry Coppee, who was the first president of Lehigh University.

Teachers College, Columbia University, celebrated its twenty-fifth anniversary on February 20 and 21, with an educational conference which brought together nearly one thousand alumni and former students of the institution. During Friday and Saturday a series of educational conferences was held at the college devoted to different divisions of the educational fields as follows: Administration and College Teachers of Education, Secondary Education, English, History, Geography, German, Mathematics, Science, Elementary Education, Kindergarten Education, Fine and Industrial Arts, Household Arts, Nursing and Health, Household Administration. The speakers included superintendents of schools, deans of university schools of education, directors of normal schools and specialists from various educational fields, college, secondary and elementary. Saturday night nearly 800 alumni gathered for a dinner at the Aldine Club. The program of the science round table was as follows:

"Use of Literature in Science Teaching," by Clarke E. Davis.

"Trend of the Times," by J. Newton Gray.

"A Method for Teaching Nutrition in the High School."

"Chemistry for Second-year High School Girls," by Henry T. Weed.

"General Science—A Method and Its Difficulties," by Roland Hugh Williams.

"An Experiment in Teaching Heat," by Carl J. Hunkins.

Professor A. L. Dean, of the Sheffield Scientific School, Yale, has accepted the call to the presidency of the college of Hawaii, at Honolulu, and will take up his duties there next autumn.

At the Massachusetts Institute of Technology Mr. J. M. Barker has been appointed instructor in civil engineering and Miss Edith A. Beckler, lecturer on public health laboratory methods.

Dr. H. F. Baker, F.R.S., fellow of St. John's College and Cayley lecturer in mathematics, has been elected Lowndean professor of astronomy and geometry in the University of Cambridge in succession to the late Sir Robert Ball.

The Manchester University Council has appointed Dr. Charles Alfred Edwards to the chair of metallurgy and metallography.

Dr. E. E. Fournier d'Albe, assistant lecturer in physics in the University of Birmingham, has been appointed special lecturer in physics in the University of Punjab, Lahore.

DR. LUDWIG DIELS, of Marburg, has been appointed associate professor of botany in the University of Berlin, and assistant director of the Botanical Garden and Museum.

DISCUSSION AND CORRESPONDENCE

FOSSIL PLANTS IN THE PANAMA CANAL ZONE

EXCEPT for the incidental mention by Pilsbry and Brown of lignified nuts in their paper on the Mollusca I know of no record of any remains of fossil plants having been found in the Canal Zone, notwithstanding the fact that the numerous Tertiary tuffs would seem to furnish an admirable matrix for the preservation of leaf impressions.

During 1912 Dr. M. I. Goldman, of the Johns Hopkins University, visited the Isthmus and in connection with his work on rock weathering devoted considerable time to a search for fossil plants along the Canal with the results indicated by the following note.

Since fossil plants of Tertiary age from the tropics have not been collected or studied to any large extent and since the Tertiary floras of Central America have a most important bearing on both the phytologic and geologic history of southeastern North America during the Tertiary, a preliminary announcement seems justifiable.

Fossil plants seem to be somewhat sparsely but widely distributed along the canal and identifiable forms were collected from the following localitites:

1. East wall of the Culebra Cut just north of station 1760 and opposite Culebra.
2. West wall of cut below Miraflores locks, where the plant-bearing tuff outcrops for about one fourth of a mile.
3. Culebra Cut under the steep hill just north of Paraiso, associated with specimens of the pelecypodian genus *Phacoides*.
4. Gatun Dam borrow pits.

The best material comes from the first of these localities and the least satisfactory from the last. The collections have not been critically studied, since it is hoped that more extensive collections will be sent in by the resident geologist of the Canal Commission.

The following forms have been recognized in a preliminary study of the collection: A fine large species of *Guatteria* which is present at several localities; a well-marked species of Myrtaceæ, probably representing the genus *Calyptranthes;* a species of *Nectandra;* a species of *Rhamnaceæ;* a characteristic small-leaved species of *Ficus;* another of *Ocotea;* a species of *Rubiaceæ* and one of *Melastomaceæ.* Petrified wood was also collected and although but three slides have been cut these show apparent identity with a species described from the Oligocene of the Island of Antigua.

None of the material lends any support to the view, at one time prevalent, that some of the Isthmian beds represent deposits of Eocene age, and while the various plant-bearing beds are probably not exactly synchronous, their floras in so far as they are known from the present small collection all appear to be referable to the Oligocene.

EDWARD W. BERRY
JOHNS HOPKINS UNIVERSITY,
BALTIMORE, MD.

WHAT GRADES REPRESENT

THE following considerations have been of service to the writer in the diagnosis of the difficulties encountered by students in meeting the scholastic requirements represented by grades, and the identifying of the obstacles has often assisted in their removal.

It is not necessary in this discussion to assume any more definite or uniform system of grading than that 100 per cent. represents a perfect grade and that there is a minimum grade required to entitle the student to credit for the course. Half way between these is what may be called an average grade. This does not mean the grade that a class would average under the usual conditions, but what a class might be expected to average if all members gave all the officially allotted time (or a reasonable time) and their best effort to the subject—quite a different matter! The instructor should make his demands such that the student of average qualifications using his best effort all the allotted time would receive the average grade—half way between the passing grade and 100 per cent.

The main factors represented by grades intelligently given may be described by the six terms: time, effort, mental ability, memory, language sense and preparation. The relative importance of these factors varies widely with the nature of the subject, but all are involved in every intellectual pursuit. The order chosen is that of directness of control by the student.

Time.—This includes both that in attendance on classes and that given to the subject outside of class hours. Irregularity of attendance on classes and deficiency of outside preparation would have their obvious results in this factor, irrespective of the reasons for such irregularity or deficiency.

Effort.—This factor includes the practise of concentration in and out of class, largely a result of past habits; thoroughness of thought, which passes nothing until really grasped; and system, which insures sustained and continuous work as opposed to cramming at intervals.

Mental Ability.—This is evidenced by the ease and accuracy with which new ideas are grasped. It is of course largely a natural endowment, developed, however, or allowed to deteriorate, slowly by its exercise or its disuse. This factor is most important in subjects of a strongly reasoning character.

Memory.—By this term is meant the retaining of ideas rather than the memorizing of words or symbols; it is mainly a natural endowment but somewhat subject to cultivation by mental activity.

Language Sense.—By this is meant the ability to understand and to use language with precision. It is probably to some degree a natural gift, but is also largely a result of early training and associations and an appreciation of its importance. The student who can not express his own ideas clearly usually receives only vague impressions from his oral or printed instruction. The language sense can be cultivated by sustained effort directed to that end.

Preparation.—This includes general education along intellectual lines, to which appeal can be made for analogies and illustrations. It also means a proper command of the earlier part of the same subject and of other subjects directly used as foundational material and as tools; grades wisely given in these antecedent subjects indicate clearly the adequacy of this direct preparation. It is in this factor that the student who has habitually aimed at passing rather than grasping his curriculum encounters the natural consequences in his increasing difficulties.

In conclusion it may be noted that time and effort are under immediate control; mental ability, memory and language sense are subject to slow cultivation; and preparation is beyond present control. Of course less than all the allotted time, or less than the student's best effort, or less than an average rating in factors, would necessitate correspondingly higher values for the other factors that an average grade might be earned.

P. N. Evans

Purdue University,
LaFayette, Ind.

SCIENTIFIC BOOKS

Elementary Studies in Botany. By John M. Coulter, A.M., Ph.D., Head of the Department of Botany, University of Chicago. New York and Chicago: D. Appleton and Company. 12mo. Pp. ix + 461.

It is a pleasure to note the gradual approach to a standard course of study in botany for the high schools of the country, and there can be no question that such an approach to standardization is occurring if one will look over the text-books prepared during the last few years. Especially is this tendency marked where the authors combine a considerable experience in the teaching of botany with a comprehensive knowledge of the science. The book before us is an excellent illustration of this fact, which the author recognizes in the opening paragraph of his preface, and which is so good that we quote it complete. "It is seven years since 'A Text-book of Botany' was published, and during this period there has been not only great progress in the knowledge of plants, but also much discussion concerning the effective use of plants in high school education. It is natural that a discussion of this kind should lead to considerable

diversity of opinion, and it is evident that no one is in a position as yet to decide the points at issue. Amid all the flux of opinion, however, there is evident a desire to relate plants more closely to the interest and to the need of high school students. This desire expresses itself in an extreme form when courses in 'agriculture' are asked to be substituted for courses in 'botany.' This has brought a distinct temptation to publishers and to authors to 'meet the demand' without much consideration as to its significance. It can not mean that all that has proved good in the older method is to be abandoned, and an unorganized mass of new material substituted for it. It can not mean that high school pupils are to become apprentices rather than students. It must mean that the structure and work of plants are to be so studied that this knowledge will enable the student to work with plants intelligently. In other words, it is intended to be the practical application of knowledge, rather than practical work without knowledge."

It would be well for teachers of botany of all classes to carefully read these sentences, which gain in strength and significance to the end of the paragraph. As the writer of this review has insisted over and over again, botany wherever taught must be botany, and not some application of botany, or some study of plants not involving the orderly sequence of structural and physiological inquiry. Agriculture, horticulture, plant breeding, forestry, etc., are most excellent subjects of study for young people (and older people, for that matter), but they are not botany; rather, they require botany as a prerequisite, and must be based upon it.

Coming to Dr. Coulter's text-book we find twenty-seven chapters arranged in two "parts." Chapters I. to XIV., inclusive, deal with what may be called "pure" botany, and in these the pupil is taken step by step from the simpler to the more complex plants and their principal functions. This part of the book is intended to afford a good half-year's work for the high school pupils, and without doubt this is one of the best formulations of this work which has yet appeared. In looking through the chapters one finds nothing which can well be omitted, nor anything which imperatively demands admission. In the second part, which is entitled "Plants in Cultivation" one finds also not a little of pure botany. Thus the chapter "What Plants Need" is plant physiology, pure and simple, as is also the chapter on "What the Soil Supplies." There is a little concession to the "practical" in the chapters on "Seeds," "Other Methods of Propagation" and "Plant Breeding," and considerably more in those on "Cereals and Forage Plants," "Vegetables," "Fruits," etc., and yet in even the most "practical" of these one sees that the presentation is by one who is primarily a botanist. All through this second part the living plant *as a plant* is emphasized, rather than the plant as a crop to be sold for such and such a sum. And here is perhaps the line of difference between the scientific conception of plant study and the conception held by those who think of plants as things to be grown for our use or pleasure. Dr. Coulter's book is a demonstration of the possibility of presenting much of applied botany in a scientific manner.

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

The Evil Eye, Thanatology and Other Essays. By ROSWELL PARK. R. G. Badger, Boston. 1913.

This volume consists of a series of entertaining essays, which, as the author states, "partake of the character of studies in that border-land of anthropology, biology, philology and history which surrounds the immediate domain of medical and general science." The subjects include The Evil Eye, Thanatology (the study of the nature and causes of death), Serpent Myths and Serpent Worship, Iatro-Theurgic Symbolism, Giordano Bruno, The Career of the Army Surgeon, The Evolution of the Surgeon from the Barber, History of Anesthesia and the Introduction of Anesthetics in Surgery, etc. The treatment in nearly every case is primarily historical, and the main purpose appears to be to show how many

customs and ideas of to-day have roots in the past which are hardly suspected by the general public. On the whole, the book makes melancholy reading, unless one can enjoy the contrast between ancient follies and our own astonishing superiority! The study of past error and confusion is certainly of value as exhibiting the weak spots in our social organism, and enabling us to be on our guard against early symptoms of decay in the societies to which we belong. Thus, the author says:

"If one attempt to scan the field of the history of medicine, to take note of all the fallacies and superstitions which have befogged men's minds, and brought about what *now* seem to be the most absurd and revolting views and practises of times gone by, and if one search deliberately for that which is of curious nature, or calculated to serve as a riddle difficult of solution, he will scarcely in the tomes which he may consult find anything stranger than the close connection, nay, even the identity maintained for centuries, between the trade of the barber and the craft of the surgeon. Even after having studied history and the various laws passed at different times, he will still miss the predominant yet concealed reason for this state of affairs. This will be found to be, in the words of Paget, the 'maintenance of vested rights as if they were better than the promotion of knowledge.'"

It is impossible to contemplate this history without asking whether to-day the "concealed reason" mentioned by Paget is not still powerful, and serving to prevent our academic institutions from readily adapting themselves to their social environment. From another point of view doubt may be expressed as to the complete validity of the author's historical method. From time to time we find fault with the professional historian, who, depending on documentary evidence, seems to over-emphasize the miseries and stupidities of former days. We like better our Morris and Scott, who offer us pictures of moving life, full of romance, adventure and high ideals. It is easy to criticize such writings, as we criticize the landscape artist who makes idyllic pictures of suburban lanes, leaving out the tin cans, dead cats and evil smells. Yet after all, life was life in those days, and the best that is in us calls across the ages to the best that equally existed in our ancestors. Dr. Park's accounts may be true as to facts, and yet to some extent misleading to those who have not other sources of information.

T. D. A. Cockerell

BEETLES BECOMING PARASITES

In all the great group of beetles, 50,000 species strong, and of an extraordinary variety of external appearance and of habit, witnessing to a ready plasticity and adaptiveness, there are but few indications of a resort to parasitism as a shift for a living. The Stylopidæ, it is true, are parasites (in the bodies of wasps, bees and leaf hoppers), but these insects are no longer considered to be aberrant beetles, but to constitute a quite distinct order, more nearly allied to the Hymenoptera or Diptera than to the Coleoptera.

The classic and single conspicuous example of a parasitic beetle, living all of its life (both larval and adult) on its host, is the well-known beaver parasite, *Platypsylla castoris*, common both in Europe and America. This insect lives as an external parasite among the hairs on the outside of the host's body, and feeds on the hairs and dermal scales, just as the Mallophaga (biting bird lice), of birds and mammals, do. It has a highly modified body, and is the only species of its genus and family.

Another small beetle, however, *Leptinus testaceus*, of the family Leptinidæ, is known in both Europe and America as a frequenter of the nests of field mice, shrews and other small mammals of similar habit. It has also been taken from bumble bees' nests. I have recently received several specimens of this beetle which were taken from the bodies of freshly killed shrews on Forrester Island, Alaska, by Professor Harold Heath. The beetle's body is not modified (by flattening, fusion of thoracic segments, etc.) in any such extreme way as is that of Platypsylla or the Mallophaga, but it shows, nevertheless, the

beginnings of such adaptive modification, and suggests plainly that the beetle's habits are probably already those of a habitual external parasite of its shrew and field mouse hosts, feeding (with simple biting mouthparts) on the dermal scales and hair.

Professor Van Dyke, of the University of California, our foremost Pacific coast student of the beetles, and from whom I have most of the information used in this note, writes that from the fact of finding *Leptinus* in the nests of bumble bees a number of entomologists have advanced the idea that the beetle lives normally in bumble bee nests and becomes accidentally carried from them by mammals that raid the nests. "This I do not agree with," says Dr. Van Dyke. Considering all of the circumstances of the few captures that have so far been made of the beetles, Dr. Van Dyke concludes that the beetle is a real parasite of the mice and shrews and "absolutely dependent on them in the same way that the Mallophaga are dependent on their hosts."

Another little beetle, *Leptinillus validus,* closely related to *Leptinus,* occurs on beavers in the Hudson Bay region. Still another beetle, *Lyrosoma opaca,* a Silphid (carrion beetle), is found in the North Pacific upon practically all of the islands and isolated ocean rocks to be found there. It breeds in rotten kelp and among old and broken murres' eggs, etc., and has been found prowling about the tenanted nests of the murres. But it is wingless, and Dr. Van Dyke believes that it is carried from island to island and rock to rock by the roosting and breeding birds of these rocks and islands, the beetles accidentally seeking shelter among the feathers of brooding or perching birds, and thus being carried off by them when they take to flight. "Only in this way," writes Professor Van Dyke, "can I account for the presence of the beetles on Bogoslov Island [the famous recent volcanic island of Alaska], for this island is but little over one hundred years old, and the insects are so delicate that they could not possibly survive longer than a few minutes in the Arctic waters."

These stages in the change from a scavenger's life to that of an external parasite, shown by the series of beetles referred to in this note, are exactly parallel with the transition stages from the wingless Atropids (Procidæ) feeding on dry bits of dead organic matter, even to the feathers and organic detritus in birds' nests, to the Mallophaga, feeding on the same bits of feathers and dermal scales, but finding them on the bodies of the birds themselves, to whom they have come to bear the relation of permanent external parasites, with no longer any capacity to live off their hosts. The next step for some of the beetles to take would be to become like the Anoplura, and find a more acceptable food in the blood of the hosts. For this their mouthparts would have to be considerably modified, but that would be no difficult matter.

VERNON L. KELLOGG
STANFORD UNIVERSITY, CALIF.

SPECIAL ARTICLES

THE DECOMPOSITION OF SOIL CARBONATES

IT has been found at the agricultural experiment station of the University of Tennessee, that excessive amounts of magnesium carbonate were entirely decomposed when left in contact with fallow soils in pots protected from leaching. Three types of soil were used, and the amounts of chemically pure precipitated carbonate of magnesia, equivalent to 16,000 pounds per acre of calcium carbonate were applied, in excess of the lime requirement, as indicated by the Veitch method. One year after the application the soils were analyzed and found to be strongly alkaline, but practically free of carbonates. Repetition of the experiment in metal rims, using 32,000 pounds of magnesium carbonate per acre, under field conditions, afforded the same observation in every one of eight treatments, four with magnesium carbonate alone and four with carbonate supplemented by manure, the analyses being made in this series after an eight weeks' period of contact. This work was begun in the spring of 1912 and final analyses were made in August, 1913.

It has hitherto been held that the conver-

sion of calcium and magnesium carbonates into silicates in soils has been due entirely to replacement of sodium and potassium and other bases in polysilicates. The writer and associates will shortly present in bulletin form conclusive evidence that magnesium carbonate reacts with and is fixed by silica (SiO_2), and that calcium to a less degree acts in the same manner.

Titanium oxide, which chemically is closely allied to silica and which is usually present in soils, was found to bring about the same decomposition as silica. The evidence secured points strongly to the nonexistence of magnesium in the form of carbonate in soils of humid climates.

It is believed that this research will throw considerable light upon the use of dolomite in farm practise.

W. H. McIntire

Agricultural Experiment Station,
University of Tennessee, Knoxville,
February 16, 1914

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION C—CHEMISTRY

On the forenoon of Wednesday, December 31, joint sessions of Sections B and C were held in the Georgia School of Technology, with Vice-president Cole, of Section B, in the chair. The purpose of the meeting was a discussion of geochemical and geophysical topics; it is referred to further in the report of Section B.

The main sessions of Section C were held at the Winecoff Hotel on Thursday, January 1, with Dr. C. L. Alsberg, vice-president of the section, in the chair. This was a joint meeting with the Georgia Section of the American Chemical Society, the secretary of which had assisted in arranging the program. There was an attendance of between fifty and sixty, and considerable interest was evinced in all of the papers presented. In the evening a smoker—which indeed partook rather of the nature of a dinner—was tendered to the visiting chemists by the Georgia Section of the American Chemical Society; a number of topical verses and songs were sung and the whole affair was most enjoyable. The secretary desires to record here on behalf of the visiting chemists their appreciation of the hospitality of the Georgia Section and to express thanks to it and to its secretary, Mr. J. S. Brogdon, for contributing so much towards the success of the meeting.

A brief account of the proceedings is appended.

The following resolution, presented by Professor Charles E. Munroe, was carried unanimously:

Whereas the Committee of this Section on Nomenclature and Notation presented at the Indianapolis meeting a report through its chairman, Dr. J. Lewis Howe, affirming the validity of the name and symbol columbium, Cb; and,

Whereas this report was accepted and adopted by this section; and,

Whereas the Committee on Inorganic Nomenclature of the International Association of Chemical Societies has reported on September 22, 1913, favoring the name and symbol niobium, Nb, for the element which was named columbium by its discoverer; and,

Whereas a later detailed investigation of the historical record by Dr. F. W. Clarke, a copy of the results of which is filed herewith,[1] finds no valid reason for the use of the name niobium;

Therefore be it resolved that we reaffirm our endorsement of the report of the committee of this section and view with regret this action of the committee of the International Association of Chemical Societies in advocating the use of the later name, thus introducing confusion where simplicity is sought.

Following this a vote of thanks, proposed by Professor Brackett and carried unanimously was accorded to the authorities of the University of Virginia, and in particular to Professor F. P. Dunnington, for their courtesy in allowing samples from their collection of the explosive materials used by the Confederacy during the War to be forwarded to Atlanta for use as illustrative material for Professor Munroe's lecture.

The Cause of Osmotic Pressure: W. V. Metcalf.

After summarizing the different theories which have been advanced, the author presented a statement and defense of Le Blanc's theory, which, though the best explanation yet offered, has up to this time not attracted as much general attention as it deserves. On this theory osmosis is considered to result from the different internal pressures of solution and solvent, the internal pressure being the resultant of the normal components of the unbalanced molecular attractions at the free surface of the liquid.

Some Possibilities of Georgia Clays: Charles L. Parsons.

In the state of Georgia all kinds of clays are to be found, so that there is no reason why all sorts of clay products should not be manufactured

[1] This has already appeared in Science, 39, 139–140 (1914).

there. Three kinds are of especial importance: the bauxite deposits, fuller's earth, and highly aluminous clays suitable for high refractories; all are of better quality than is commonly found elsewhere, and only require proper technical investigation and control to insure their successful commercial utilization.

Permeability Measurements as an Aid in Proximate Organic Analysis: A. M. Muckenfuss.

A general discussion of a method of measuring the relative permeability of films (*e. g.*, of paint or oil) to water vapor, and of the usefulness of such results as an aid in characterizing the film or membrane. The apparatus and method have been described previously.[1] As an example of the results obtainable, curves illustrating the effect of the presence of menhaden, tung or corn oil in films of linseed oil were shown.

Manufacture of Carbon Dioxide and Its Incorporation into Water: W. P. Heath.

For the production of carbon dioxide on a commercial scale five methods are employed; most usually it is done either by combustion of coke in a special furnace, or by the action of acid on marble or dolomitic limestone. Some anomalous effects have been observed in the behavior of aerated waters as ordinarily made—for instance, that the pressure inside a freshly charged bottle may increase considerably; these effects are attributed to admixture of air with the carbon dioxide.

Walnut Stain in the Killing of Fish: G. P. Shingler.

Green walnuts or oak bark thrown into water will kill fish very quickly. Investigation of this question showed that in either case both narcotin and tannin are present in the solution and indicated that the latter is the active poisonous agent.

Sanitary Water Analysis in Relation to Public Health: Ray C. Werner.

A plea for the importance of thorough control of water supplies, for the need of education in regard to this matter, and for effective inspection of filtration plants, together with regular tests—both chemical and bacteriological—of the water as delivered to the consumer.

Cotton Seed Meal as a Possible Food for Man: C. A. Wells.

A general discussion of the possible utilization of cotton seed meal as a food for man, of its digestibility and toxicity, and of its food value, especially with regard to its cheapness as a source of protein.

[1] *J. Ind. Eng. Chem.*, July, 1912.

Studies of the Chemical Composition of Cotton Seed: C. L. Hare.

A record of work at the Alabama Experiment Station which was undertaken in order to ascertain whether it would be possible by breeding cotton to improve the seed in the direction of a larger oil content and higher protein content, though of course without prejudice to the amount and quality of the fiber; but up to the present little definite progress has been made. Apparently there is no relation between the amount of lint and that of oil or protein; but the amount of oil seems to bear some relation to the weight of the seeds, to the percentage of protein, and, possibly, to the amount of inorganic constituents.

Occurrence and Composition of Some Alabama Phosphates: B. B. Ross.

Large quantities of phosphate-bearing strata are found in Alabama, apparently closely associated with a thick bed of rotten limestone and with green sands; their formation is ascribed to a leaching of this phosphatic limestone. This view is confirmed by analyses of boulders, which showed that the weathered layers contain considerably less phosphate than the unweathered portion. Much of this phosphate deposit could not be worked economically at the present time, but it may be capable of later development when other fields become partly exhausted. The green sands contain both potash and phosphate, and many possess local value as a fertilizer.

Rubber Substitute from the Holly: Charles P. Fox.

According to a recent French invention a rubber substitute may be made from the holly. Similar experiments with American holly showed that the amount of extract is too small to be remunerative; further, that addition of this extract to reclaimed rubber delays vulcanization, increases the elongation and permanent set, but does not increase its tensile strength.

Mexican Petroleums: Morris O. Gottlieb.

Chemistry in Relation to the Development of the Fertilizer Industry: J. S. Brogdon.

An Incompatibility in Fertilizer Mining: T. E. Keitt.

When basic slag is mixed with muriate of potash or kainit a large proportion of the potash becomes insoluble in water. The insoluble compound thus formed is very slightly soluble in neutral am-

monium citrate of sp. gr. 1.09, and only slightly soluble in citric acid, but is readily soluble in hydrochloric acid of sp. gr. 1.115.

Two Partially Compensating Sources of Error in the Official Method of Determining Potash: T. E. KEITT.

In the official method there are two sources of error, one the diminished volume due to precipitation of the iron, alumina and tri-calcium phosphate when ammonia and ammonium oxalate are added to the solution after boiling; the second due to occlusion of potash by the above precipitate.

An Odd Result in the Chemical Analysis of a Potable Water: F. P. DUNNINGTON.

Analysis of the water from a newly bored well showed astonishingly high amounts of nitrates, nitrites and chlorides, even after the well had been pumped dry twice. A full explanation lies in the circumstance that the party boring the well wound up by exploding a charge of dynamite "to open up crevices for water" and then to ensure a good job, put some salt in the well. In cleaning out wells some people complete the work by putting salt or lime into the well—an ill-advised custom, frequently encountered in certain regions.

In addition to the above papers there were two informal talks: one by Dr. C. L. Parsons on the radium situation and the capabilities of radium in the cure of cancer, the second by Dr. R. K. Duncan, who described the general organization of the scheme of fellowships in industrial research and recounted a number of the problems upon which the men working under this scheme are engaged; both of these talks were very interesting, and impressed those who heard them.

JOHN JOHNSTON,
Secretary of Section C

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION F—ZOOLOGY

SECTION F—Zoology—of the American Association for the Advancement of Science held its convocation week meeting in the histological building of the Atlanta Medical College, Atlanta, Ga., December 29 and 30, 1913.

Professor Frank R. Lillie, of the University of Chicago, was elected vice-president and chairman of the section for the ensuing year. C. C. Nutting, Iowa University, was chosen member of the General Committee of the association; Herbert Osborn, Ohio State University, was elected a member of the sectional committee (for 5 years), and E. W. Gudger, Normal College of North Carolina, was made a member of the council of the association.

The following papers were presented at the meeting, either in full or by title:

The Behavior of Leeches with Especial Reference to its Modifiability: WILSON GEE.

The first section of the work reviewed in this paper deals with the reactions of leeches to various classes of stimuli, such as light, chemicals, contact, currents, etc. The second section is an attempt to present, so far as possible, a causal explanation of the modified behavior described in the nephelid leech, *Dina microstoma* Moore. The different responses to the same stimulus were shown in their essential features to be in accord with our knowledge of reflex-arc structure and what might be expected of its conductivity in the various stages of excitement of the leech. Acclimatization to slight stimuli, such as shadows and shocks, was explained on the basis of the dulled sensibility of the receptors and slight changes in the nerve centers involved. It was shown that the phenomenon of fatigue in the leech possesses the same fundamental characteristics as fatigue in skeletal muscle. An important factor in explaining the behavior of the leech at a given moment was shown to be the consideration of the concurrent stimuli operative at that moment. Perhaps intermediate metabolic products are the cause of much of the difference in responsiveness between normal and well-fed leeches. The increased irritability of starved leeches is probably due to much the same cause.

Additional Data on Some of Eisen's Species of Lumbricidæ: FRANK SMITH.

Eisen in 1874 published a list of *Lumbricidæ* from Niagara and from Mt. Lebanon, New England, in which he described four new species. One of them is the widely distributed and well-known *Helodrilus parvus*. The other three species have not been reported since. Eisen gave only brief descriptions of their external characters and their real status has been uncertain. The United States National Museum has specimens of each of these three species which were given by Eisen many years ago, and are accompanied by labels showing that they were part of the original collections on which the descriptions were based. They are in the collections of *Oligochæta* which have been turned over to the writer for study. Sections have

been made and some of the more important facts of their internal anatomy determined. With the permission of the Secretary of the Smithsonian Institution, I make known some of the results of this preliminary study. *Helodrilus tenuis* has paired sperm sacs in XI. and XII. only, and has no spermathecæ. It belongs to the *Bimastus* section of the genus and is the same as *H. constrictus* (Rosa), described in 1884. Its relation to *H. norvegicus* (Eisen) is as yet uncertain. *H. tumidus* has sperm sacs in XI. and XII. only, and has no spermathecæ and hence belongs to the *Bimastus* section of the genus as has been assumed by Michaelsen. *Tetragonura pupa*, now regarded by Michaelsen as simply a form of *Helodrilus tetrædrus* (Savigny), is represented in the collection by a single specimen which, although labeled by Eisen as *Tetragonura pupa*, has spermiducal pores on XI. instead of on XII., as described by him. All of the reproductive organs and the crop and gizzard are four somites anterior to the position normal for Lumbricidæ. There is but one pair of "hearts" and they are in VII. The entire anatomy of this specimen is that which might be expected if a specimen of *Helodrilus tetrædrus hercynia* (Michaelsen) had lost the anterior nine somites and regenerated the usual number of five new ones. We do not know how many specimens Eisen may have had and it is certainly unsafe to assume that his description was based on this particular specimen. The real status of this species seems as uncertain as before. (These results will appear later under a different title in a more extended paper from the United States National Museum.)

A Study in Strongyloid Parasites of Cattle and Sheep in South Carolina: A. F. CONRADI.

Among the nematode parasites occurring in the digestive tracts of young cattle and sheep in South Carolina, the stomach worm, *Hæmonchus contortus* and the hookworm of cattle, *Monodontus phlebotomus* are very important. An extended study of these parasites was made covering a period of several years. The stomach worm occurs in both young cattle and sheep in injurious numbers. Hookworm has not been found injurious in sheep, but among cattle this is a species to be reckoned with. The life history of the two species is very similar. The eggs are laid in the stomach and after passing from the animal hatch in from three days to several weeks, depending on the temperature. In our work the stomach worm was almost altogether confined to the fourth stomach, while the hookworm was confined to the upper eight feet of the intestines. While the hookworm fastens itself to the intestinal wall and sucks blood, we were unable to prove this in case of the stomach worm. These occur in the mucous secretion between the mucous membrane of the stomach and the ingesta and are very rarely attached. Even when the specimen is attached it is but feebly so and can be removed, while in the case of the hookworm often the head is torn off when trying to remove it with the forceps. A vulnerable point in the control of both species lies in the fact that moisture is absolutely necessary for the egg and young larval development. This is true in the laboratory, and experiments in the field have shown that this point can be taken advantage of. A heavily infested lot being about one half creek bottom and one half hillside was divided so as to separate the lowlands from the highlands. An equal number of calves of the same age were placed on these lots in the early spring and these animals received the same amount and kind of feed, except that those in the lower lot obtained their water from a running brook. At the end of the season we had 62½ per cent. more calves on the upland than on the lowland. The following year all calves were kept on the upland and no death occurred. In our work the heaviest egg record occurs during June and July, while the death rate begins the latter part of August and continues through September and October. In our work no young calves born after August 25 took the disease, while the parasites left infested animals at from ten to fourteen months of age.

On the Whale Shark, Rhineodon typus: F. W. GUDGER.

The Eruption of the Permanent Teeth: ROBERT BENNETT BEAN.

Data for 2,221 school children. The eruption of the permanent teeth in the Filipinos is from one to four years earlier than in the Germans and Americans; females are more precocious than the males in all three groups. The lower permanent teeth erupt before the upper ones, except that the upper premolars erupt before the lower.

The teeth erupt in the following order: (1) Lower first molars; (2) lower median incisors; (3) upper first molars; (4) upper median incisors; (5) lower lateral incisors; (6) upper lateral incisors; (7) upper median premolars; (8) lower canines; (9) lower median premolars; (10) upper lateral premolars; (11) upper canines; (12)

lower lateral premolars; (13) lower second molars; (14) upper second molars; (15) lower third molars; (16) upper third molars.

The law of eruption is as follows: There are one or more periods of acceleration alternating with periods of retardation in the development of any one of the structures of the body. The periods of acceleration in the development of one structure may be synchronous with the periods of retardation in the development of another structure. Thus the period of the first six months after birth is one of rapid growth of the body in length, and this is followed by a period of comparative rest of the body while the eruption of the temporary teeth is taking place, all of which are through the gums by the end of the third year. This activity in dental growth is followed by a period of rest. Following this there is a second period of rapid growth in stature, subsequent to which the permanent teeth begin to erupt, after which the growth of the body is again accelerated, to be followed by a second rapid eruption of the permanent teeth and then another rapid growth of the body which is succeeded by puberty. The temporary teeth of the Americans are worse than those of the Filipinos which are worse than those of the Germans. The girls have worse teeth than the boys in all groups. The eruption of the teeth is one of the most exact means of determining the relative development of the individual and may be used as a physiological standard to determine the relative development.

Some Curious Parasites, Commensals, etc., Found on Alcyonaria: C. C. Nutting.

1. Discussion of the meaning of terms used to indicate the associations of animals discussed in the paper, and the analogies found in the *Alcyonaria* to plants.

2. Commensals found on *Alcyonaria*. (*a*) Those which are apparently harmless and do not modify the structure of the hosts. Illustrated by basket-fish, serpent stars and mollusks. Similarity in colors to the hosts. Possible advantage of association to commensals. (*b*) Those which directly modify the structure of the host, but do not subsist upon its tissues. A genus (*Calypterinus*) founded on such modification. *Stenella helminthophora,* in which the scale-like spicules have been remarkably modified to form a refuge for an annelid. *Calyptrophora ijimæ,* in which a web-like membrane including numerous spicules is formed by an annelid. *Echinogorgia pseudosassapo,* in which a barnacle has produced gall-like swellings in which it finds protection. *Solenocaulon,* in which it is claimed the leaves are modified to form arcade-like retreats for a macrouran crustacean, and, in another case, a brachyuran. (*c*) True parasites, apparently subsisting in part or in whole on the tissues of the host. *Chrysogorgia arborescens* with polyp bodies enormously enlarged by a parasitic crustacean of degraded type. *Suberia excavata,* in which the axis cylinder is extensively tunneled by a bivalve, and in which a degenerate annelid has also been found. (*d*) Parasites which do not live upon the tissues of the host, but which destroy it by strangulation. Millipores entirely covering an alcyonarian colony. Colonial anemones entirely covering a colony of *Caligorgia gilberti.*

An Experimental Comparative Study of the Behavior of the Animals of Two Aquatic Animal Communities: Victor E. Shelford.

The rapids and pool communities have been compared. The rapids community is characterized as *positive* to *strong current* and *negative* to *sand bottom,* while reaction to light, contact and gravitation are in accord with the position in which the animals live, *i. e.,* whether *on, under* or *among* stones. The pool community is *positive* to sand bottom, but only in part positive to current. It differs from the pool community in reactions to all the factors used. Those animals that are positive to current have a different optimum, hence animal communities differ in their behavior reactions.

Are the Preotic Myotomes of the Vertebrate Head Postotic in Origin? H. V. Neal.

The assumption of an exogenous origin of the otic region by Fürbringer ('98) and for both postotic and preotic regions by McMurrich ('12)—appears untenable in the light of the evidence. As pointed out by Johnston ('05) Fürbringer's inferences appear fallacious as a result of his failure to appreciate the relations of the nerve components in the occipital region. The main support for McMurrich's conclusions is therefore rendered doubtful. While the relations of the posterior rectus muscle of the eye to a postotic nerve—the abducens—might appear to favor the postotic derivation of that muscle, the relations of the remaining eye-muscles to nerves having preotic niduli do not support this opinion. Moreover, if McMurrich's assumption were true, it would appear necessary to assume the migration of somatic motor niduli from postotic into a preotic position and the associated migration of the mandibular and hyoid arches with which the myo-

tomes of the eye muscles are connected. The discovery of Van Wijhe's ('82) somites in Cyclostomes (Koltzoff '02) and of a similar mesodermic segmentation in the preotic region of bony fishes (Boecke '04) and of reptiles (Filatoff '07) taken in conjunction with the evidence of their presence in Amphibia (Miss Platt '97) and the repeated confirmation of their existence in Selachian embryos by Hoffmann ('94), Neal ('96, '97), Sewertzoff ('98) and Johnston ('09) attests not only the presence of a primary preotic segmentation, but also indicates that the mesodermic segmentation, as in *Amphioxus*, is continuous from the preoral region backwards through head and trunk. The recent rehabilitation of *Amphioxus* by Delsman ('13) as a transition form between annelids and vertebrates is symptomatic of the recent trend of morphological opinion. A fuller discussion of the problem will be given in a forthcoming number of *The Journal of Morphology*.

The Story of Human Lineage (vice-presidential address): WILLIAM A. LOCY.

Microscopic Demonstration of Fecal Contamination of Food, as Evidenced by the Presence of Protozoan Spores: C. W. STILES.

Instruction of Young People in Respect to Sex: T. W. GALLOWAY.

In a brief discussion like this some things must be assumed. Among these things we may mention the following: (1) Reproduction and sex, next to hunger and the need of food, is the most profoundly influential factor in human life. It is basal to society and to particular organization of society. (2) Anything which bulks as large in human life as sex can not be unimportant in education. (3) Its greatest meaning in education is not in connection with its abuses, perversions and dangers, but rather in the normal, wholesome and constructive contribution which it makes to health,—physical, mental, social, moral and religious. (4) Consequently sex instruction means not emphasis of the pathology of sex, but of the normal development of human personality and society because of, and by means of, the impulses growing out of sex. It deals with cleanness, purity, marriage, home, fatherhood, motherhood, children, parental care, chivalry and the like. (5) In the normal human child there is no such thing as ignorance and innocence with respect to matters of sex. The only choice we have is whether the information will be clean and correct and free from vile and vulgar connotations, or will be incomplete, suggestive and curiosity-inspiring. (6) Even if we could keep children ignorant, there is in the long run no positive correlation between ignorance in respect to vital and far-reaching phenomena and safe, wise adjustment to these phenomena. There *is*, however, a correlation between knowledge and right conduct, howbeit the correlation is not 100 per cent. (7) We must, therefore, have from some source, adequate instruction in respect to matters of sex. (8) We all agree that their instruction ought to come from parents and others similarly related to the child. (9) We know, however, that this is not being done by the present generation of parents in any serious degree. We know, furthermore, that the present-day parent is not fitted to do it properly. (10) We need, therefore, to prepare a generation of parents who can do this work for society. This must be done by social agencies outside the family. (11) Colleges and normal schools are in position to do two things for the people coming to them: (*a*) They may give the kind of instruction which parents ought to have; and (*b*) they may train future teachers in a fundamental knowledge of these matters so that they may bring help to the present-day generation of parents—through parent-teacher associations in the interest of the child.

The discussion of Professor Galloway's paper was led by Professor E. B. Wilson, of Columbia University, and was participated in by several members of Section F.

Variation in Oxyurias: Its Bearing on the Value of a "Nematode Formula": STANLEY B. FRACKER.

Owing to the difficulty of classifying Nematoda certain writers have used a "nematode formula" in their descriptions. This formula shows the proportions of the body structures of the individual worm described. The investigation which this paper reported consisted of the measurement of a large number of individuals of *Oxyurias vermicularis* Linn. to determine the variation in the species. The range proved sufficiently great to throw doubt upon the value of a formula. The conclusion was reached that while the general proportions of the organs of a round worm have a taxonomic importance, the formula as it has been used is likely to be more misleading than valuable. The full paper is to be published soon.

The Development of the Olfactory Nerve and Its Associated Ganglion in Lepidosteus: CHAS. BROOKOVER.

The olfactory nerve and the nervus terminalis

has been followed in its developmental history in a graded series of embryos and larval fishes to the adult condition. The olfactory nerve and the nervus terminalis are interpreted as arising together from the ectodermal nasal placode in the same way as was previously found in *Amia* and *Ameiurus*. The ganglion of the nervus terminalis can not be recognized with certainty until a late embryological stage (about 100 hours from fertilization) and later is divided into a compact central ganglion and a more diffuse peripheral ganglion in or near the nasal capsule. In the adult fish the central ganglion is located on the ventral side of the olfactory nerve anterior to the masticating muscles about an inch rostral of the brain. It can not be positively stated that there is fibrous connection with the other cranial nerves, but a large ramus of the fifth nerve runs in the same bony channel. We have recently found more than two hundred large ganglion cells associated with the olfactory fila in adult man that have been interpreted as belonging to the nervus terminalis. Full paper to be published in *Journal of Comparative Neurology and Psychology.*

The Library of Congress as an Aid to Scientific Research: E. W. Gudger.

The Library of Congress, the national library in fact if not in name, contains about 2,000,000 books, including the priceless Smithsonian Collection, and is the richest depository of the kind in the new world. These books, including sets of scientific periodicals and proceedings of learned societies, are, under very liberal regulations and restrictions, available for the use of those doing serious scientific research work anywhere in the United States. Further, the library maintains a division of bibliography the services of which are available to the research worker for the settling of bibliographical questions, for perfecting incomplete references, for compiling lists of references, and even for copying out brief extracts. On the other hand, to the scientific man, visiting Washington for the purpose of making use of the Library of Congress, every facility for work is accorded upon the presentation of proper credentials. He is given a room or an alcove in which to work, may even be admitted to the stacks, and if necessary may have an attendant or stenographer, while there is no limit to the number of books he may have on his table for reference. In short, it is the purpose of the librarian of congress and his associates to supply the unusual book for the unusual need, to make the national library the greatest reference library in America, and the speaker, having during the past seven years borrowed hundreds of books from it, is able to testify that this purpose is not a matter of theoretical intention, but of actual achievement. This being the nearest large library to the South, it has seemed well, at a meeting of the American Association for the Advancement of Science, held in a southern city and attended largely by southern men, to call the attention of Section F and of the whole association to the great function of this great library.

A Demonstration of the Ears of Some White and Colored People of New Orleans, La.: Robert Bennett Bean.

During the past three years and more I have collected about 200 ears of colored people in New Orleans, and about as many more of white people, some of which are preserved at the Smithsonian Institution, and the remainder at Tulane University. I measured the ears after classifying them according to my grouping of hyper, meso and hypo forms, but I found that many of the ears of the colored people were unlike any of the three forms, and I call them negroid ears. I had previously collected the ears of Filipinos and placed them in the Smithsonian Institution, and in addition to the ears that I have collected and measured I have examined thousands of ears of Filipinos, Negroes, white people and others, therefore, I feel qualified to classify the normal ear. The ears of the white people may be grouped into three forms which will be described briefly as follows: The hypo ear is a small round ear, that has a deep concha, with a raised helix, that makes the ear look like a shallow bowl. The meso ear is large, often almost rectilinear, and somewhat flattened, and not so bowl shaped as the hypo ear. The hyper ear is long, narrow and usually small, with everted tragus, antitragus and anthelix and rolled back helix. The meso ear seems to be the form from which the others have been derived, and the hypo and hyper forms have apparently undergone a greater amount of retrograde metamorphosis than the meso ear. The three forms are found among the colored people in almost as great purity as among the white people, but the most usual condition of either form is to present a certain amount of wrinkling of the helix as if it had been shriveled, and in contracting the ear is distorted. The ear of the Negro also appears in the form described by Hrdlička, which is small, almost square and flat against the head. The ears of the colored people are, as a rule, smaller than those of the

white people, and this in connection with the wrinkled condition and the presence of the ear described by Hrdlička has led me to consider the Negro ear as having undergone a greater amount of retrograde metamorphosis than the ear of the white people, even a greater amount than the hypo or hyper forms. I am at present at work on the development of the ear of the fetus in the colored people to determine the extent of development of the ear in the early stages of fetal development in order to find the extent of retrograde metamorphosis.

The First-year Zoology Course: John P. Campbell.

The first-year zoology course is of special importance, for the reason that most students go no farther. It should, therefore, have the widest human interest possible, and be no more technical than is necessary, in order to give the largest returns to the greatest number. As usually conducted, this course consists of a more or less intensive study of a few types, the idea being that the benefit to be derived is directly proportional to the amount of contact with these in the laboratory. This is believed to be wrong, and the idea is urged that the amount of laboratory time should be just enough to develop a mental attitude in the student, and put him in sympathy with the methods by which the subject has been developed. If the laboratory work consists merely in verification, no amount will do this, but if it is properly conducted, this result may be reached in less time than is commonly used. Emphasis should be laid also on the historical and philosophical aspects of the subject, and for this purpose students should be required to do wide reading and make ample abstracts. Every effort should be made to have the student get a large view of nature, and he should be able to interpret as well as observe. General discussions should be introduced wherever possible. Zoology is the study of animal life, and the more contact with life is presented, the stronger is the course. Morphology in the old sense has passed away, but the more the student learns to interpret structure in terms of modification in relation to environment, the more is he likely to be mentally awakened. The order of presentation is most important and, in the writer's experience, few students are intelligently interested in the Protozoa, if they are used to introduce the course. Insects serve much better as an introductory subject, after which evolution may be taken up. If then the insects are reviewed and the remaining Arthropods taken up in the light of evolution, the study of the tissues in these leads logically into the Protozoa, after which the remaining phyla may be taken up in ascending order. The success of this course should be measured by the reaction of the student, and the proportion that are attracted to take the more advanced work, in which, of course, different methods should be pursued. The round-table discussion of Professor Campbell's paper was led by Professor Galloway.

The Content of a First Course in Zoology: T. W. Galloway.

I. This is so conditioned by what we desire to accomplish that I want to outline briefly some of the more important things I think we should try to do for the pupil in such a course. (1) We should produce and conserve a vital interest in animals. (2) We should secure an appreciation of the human values of animals. (3) We should encourage the attitude in the student of raising and solving problems concerning animals. This means the scientific attitude and the scientific method. (4) The pupil should have some ability to use the library, the field and the laboratory in pursuit of these interests. (5) He should be able to sustain interest in such problems for considerable periods. (6) There should be some sense of the way in which organisms respond to the environing conditions; some conception of individual development, and of the evolutionary series of animals. (7) The pupil should have some knowledge of the cell and of protoplasm as basal in plant and animal life. (8) He should get some practical experience in classifying organisms. (9) He should have a conception of the place of man in the biological series, and in such a way that it will heighten rather than diminish his appreciation of the meaning of the higher human qualities. (10) We should secure for him a sane appreciation of the origin and meaning of reproduction and sex, and of its bearing on human life.

II. It follows from the above that the point of view can not be narrowly morphological. Such, or all, of the possible approaches must be used as will contribute to these ends. Morphology, physiology, ecology and distribution, classification, touches of embryology and such general questions as evolution, heredity, history of biology and the like, must be included. Morphology alone secures little more than a certain deftness of observation and expression. Only when it is enriched by the more vital aspects do we secure discrimination, and the making and testing of general conclusions. The

pupil is entitled to "follow thru" in his mental processes.

III. Life is too short for these results to be accomplished by the laboratory alone or chiefly. The value of laboratory work is not in the zoological information gained by means of it. Its chief value is to enable the pupil to appreciate how the information got into the books, to give him skill in working out things for himself, and to use the increased interest he has in handling objects rather than in reading descriptions of them. It appears to me that about one half the time should be given to laboratory and field work, with more emphasis on the latter than is usual, and one half to class room, library and museum. I conceive that very much more use should be made of the library and somewhat less than is customary of the text or the lecture.

IV. I suggest the following for guidance in the selection of forms to be used in the laboratory study. They should be from those groups that have most human meaning; that are most common in the environment of the pupil; that have fewest disagreeable and repelling points; that illustrate best the great underlying processes and relations which we desire the pupil to get. Such a course might very appropriately emphasize the Protozoa, the Worms, the Mollusks, the Arthropods and the Vertebrates, in the laboratory and the field. The library and the museum may very well supply such synoptic view of the other groups as is needed in the first course.

It is quite difficult but quite important to remember that we are concerned to develop human beings and not in a mere logical display of zoological material. There is no necessary correlation between the two processes.

Note on the Present Status of the Gipsy Moth Parasites in New England: L. O. Howard.

Some Notes Regarding the Natural History of the Mole Cricket: E. L. Worsham.

The Jassidæ of Maine and their Bearing on the Distribution of this Group in America: Herbert Osborn.

Collections during the summer of 1913 greatly extend the records of the species in this family for Maine. For the most part these simply extend known range from adjacent localities, but in some cases from such distant points as Michigan, Iowa and even the Rocky Mountain region.

H. V. Neal,
Secretary

Tufts College, Mass.

SOCIETIES AND ACADEMIES

THE AMERICAN PHYSICAL SOCIETY

A regular meeting of the Physical Society was held at Columbia University, New York, on February 28, when the program was as follows:

"Radiation Constants of a Nitrogen-filled Tungsten Lamp," by W. W. Coblentz.

"The Villari Critical Point in Ferromagnetic Substances," by S. R. Williams.

"Motion of a Radiating Oscillator," by E. B. Wilson.

"A Method of Rapidly Extracting, Purifying and Compressing Radium Emanation," by William Duane.

"On the Asymmetric Distribution of Velocities of Photo-electrons from Platinum Cathode Films," by Otto Stuhlmann, Jr.

"On the Density of Radiant Action," by William Duane.

"Secondary Electron Emissions from a Hot Cathode Caused by Positive Ion Bombardment," by Irving Langmuir.

A. D. Cole,
Secretary

THE AMERICAN PSYCHOLOGICAL SOCIETY

The New York Branch of the American Psychological Association met in conjunction with the Section of Anthropology and Psychology of the New York Academy of Sciences, at Princeton, on February 23. The program was as follows:

"Some Tests of Efficiency in Telephone Operators," by Dr. H. C. McComas.

"Transfer and Inference in the Substitution Test," by Professor H. A. Ruger.

"A Comparison of the Effects of Strychnine and Caffeine on Mental and Motor Efficiency," by Dr. A. T. Poffenberger.

"A Comparison of Stylus and Key in the Tapping Test," by Dr. H. L. Hollingworth.

Inspection of the Psychological Laboratory of Princeton, and informal reports of work in progress.

"An Experimental Critique of the Binet-Simon Scale," by Carl C. Brigham.

"The Work Curve for Short Periods of Intense Application," by Professor R. S. Woodworth.

"Recall in Relation to Retention," by Dr. Garry C. Myers.

H. L. Hollingworth,
Secretary